APPENDICES

Appendix A

Glossary

Glossary of Abbreviations

ANGCGC	ANG Coal Gasification Company
ANR	American Natural Resources Company
Bcf	billion cubic feet
BLM	Bureau of Land Management
BOD	Biological Oxygen Demand
Btu	British thermal unit
CEQ	Council on Environmental Quality
cfs	cubic feet per second
dBA	decibels A weighted
^{o}C	degrees Centigrade
^{o}F	degrees Fahrenheit
DO	Dissolved Oxygen
EPA	Environmental Protection Agency
FPC	Federal Power Commission
ft	feet
FTU	Formazin Turbidity Units
GMA	Game Management Area
gpd	gallons per day
gpm	gallons per minute
HHV	Higher Heating Value
km	kilometer
KV	Kilovolt
L_{90}, L_{50}, L_{10}	Loudness 90,50,10. That dBA level exceeded 90 percent of the time, 50 percent of the time, or 10 percent of the time.

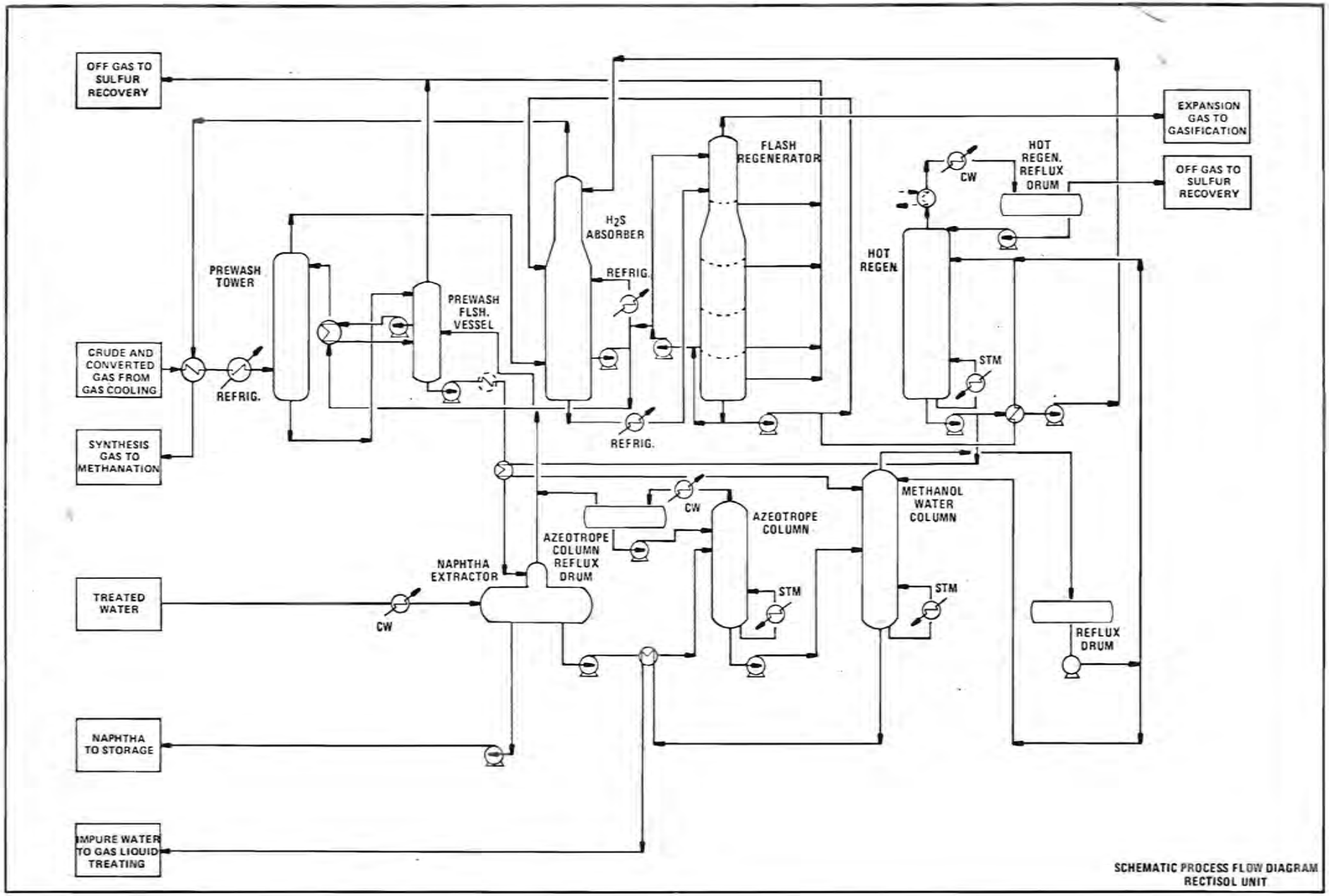
lb	pound
ug/m^3	microgram per cubic meter
mg/l	milligrams per liter
mg/m^3	milligrams per cubic meter
MMcf	Million cubic feet
Mcf	Thousand cubic feet
MCD	Mercer Census Division
MDU	Montana-Dakota Utilities
MW	Megawatt
m/sec	meters per second
NACCO	North American Coal Corporation
NGPC	Natural Gas Pipeline Company of America
NWR	National Wildlife Refuge
ppm	parts per million
PSC	Public Service Commission (North Dakota)
psig	pounds per square inch gage
REA	Rural Electrification Administration
ROW	right-of-way
scf	standard cubic foot
SNG	Synthetic Natural Gas
SWC	State Water Commission (North Dakota)
mi^2	square miles
Tcf	Trillion cubic feet
TDS	Total Dissolved Solids
tpd	tons per day
tph	tons per hour
TSP	Total Suspended Particulates
USGS	U.S. Geological Survey

Chemicals

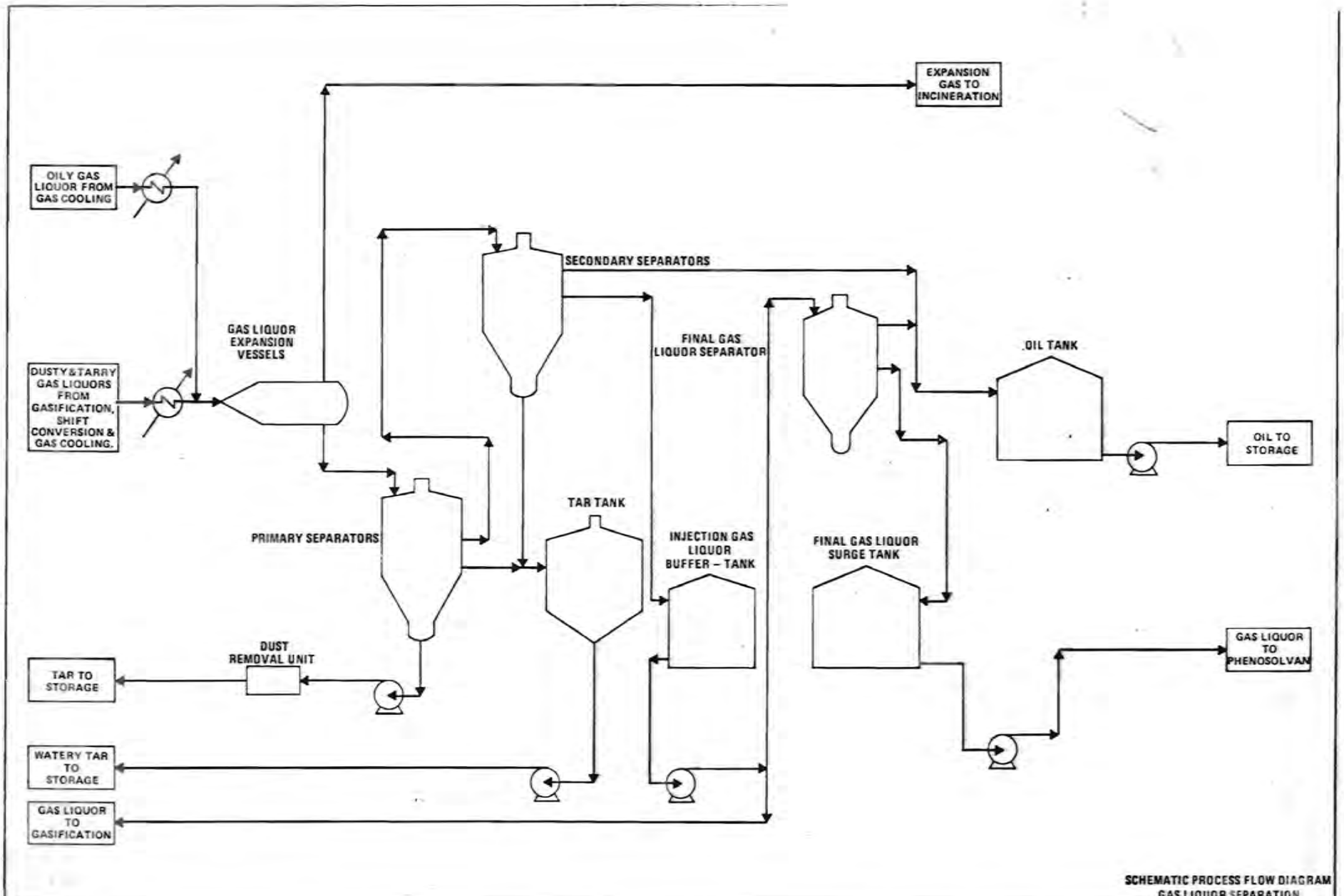
As	arsenic
B	boron
Ba	barium
Be	beryllium
Br	bromine
C	carbon
Ca	calcium
Cl	chlorine
CO	carbon monoxide
COS	carbonyl sulfide
CO_2	carbon dioxide
CH_4	methane
C_2H_8	ethane
F	fluorine
HC	hydrocarbons
HCN	hydrogen cyanide
Hg	mercury
H_2S	hydrogen sulfide
Mn	manganese
Na	sodium
NO_x	oxides of nitrogen
NO_2	nitrogen dioxide
NH_3	ammonia
Pb	lead
SO_2	sulfur dioxide
SO_4	sulfate
Zn	zinc

Appendix B

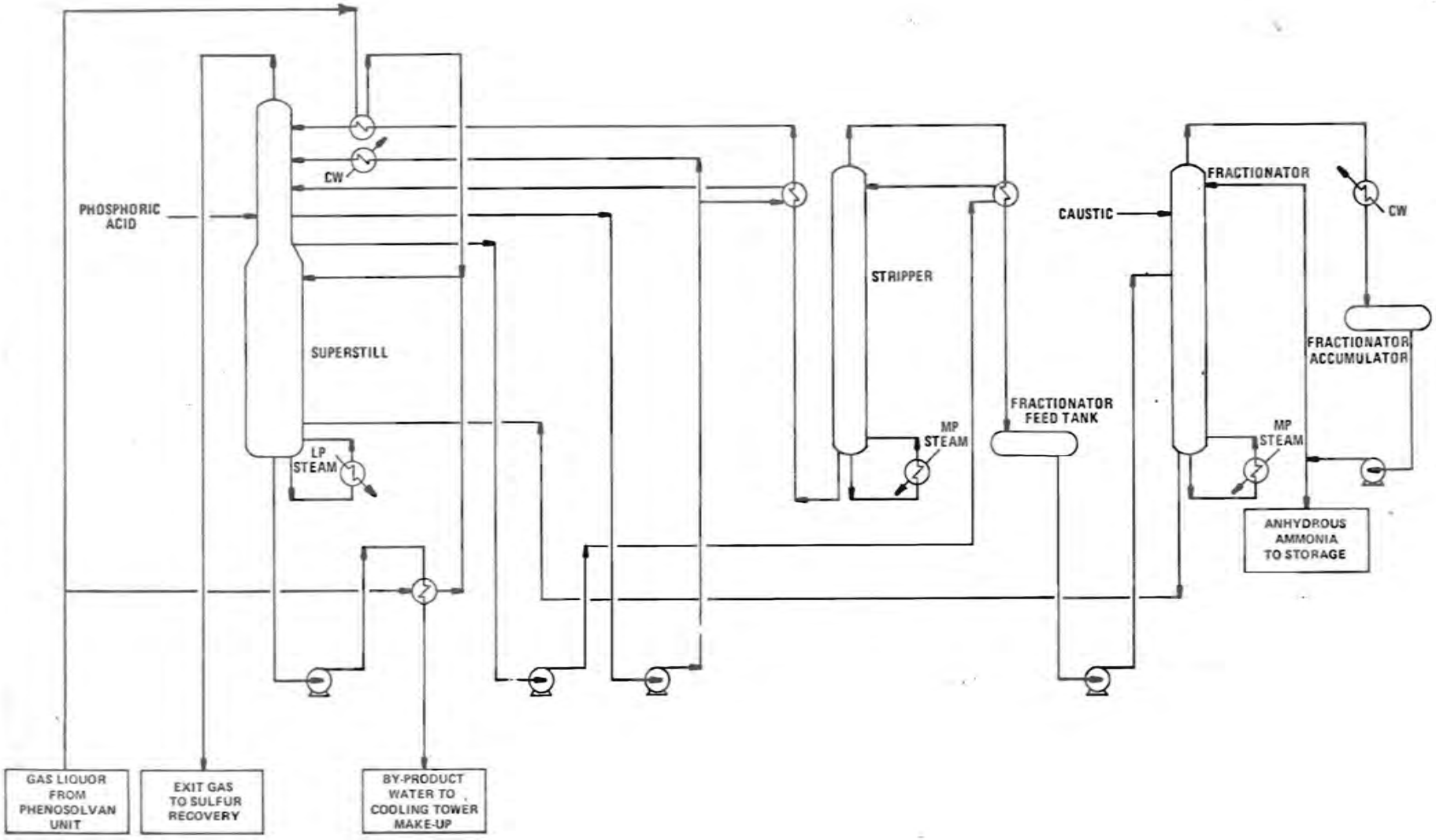
Flow Diagrams for Rectisol, Gas Liquor Separation,
and Ammonia Recovery
Gasification Material Balance
Trace Element Mass Balance
Plant Energy Balance
Pollutant Emissions and Abatement
Sulfur Disposition Diagram
North Dakota Health Department Letter



SCHEMATIC PROCESS FLOW DIAGRAM
RECTISOL UNIT



SCHEMATIC PROCESS FLOW DIAGRAM
GAS LIQUOR SEPARATION



SCHEMATIC PROCESS FLOW DIAGRAM
AMMONIA RECOVERY

GASIFICATION MATERIAL BALANCE[1]

Input	From	To	lbs/hr.
Coal	Coal Handling	Lurgi Gasifiers	2,236,780
Steam + BFW	Steam Generation	Lurgi Gasifiers	2,363,775
Oxygen	Air Separation Plant	Lurgi Gasifiers	452,685
Water	Steam Condensate Return	Rectisol	62,170
Total			5,115,410
Output			
Ash	Lurgi Gasifiers	Ash Handling	146,940
Tar	Gas Liquor Separation	Plant Fuel	70,120
Tar Oil	Gas Liquor Separation	Plant Fuel	11,815
Crude Phenol	Phenosolvan	Plant Fuel	13,550
Naphtha	Rectisol	Plant Fuel	11,340
Ammonia	Ammonia Recovery	Sales	17,800
Dephenolized Water	Phenosolvan	Cooling Tower	2,199,945
Off-Gas	Rectisol	Stretford Sulfur Recovery	1,819,710
Output			
Tail Gas	Ammonia Recovery	Stretford Sulfur Recovery	47,555
Condensate	Methanation	Steam Generation	297,475
Expansion Gas	Gas Liquor Separation	L.P. Flare	5,700
Product SNG	Product Gas Compression	Sales	473,460
Total			5,115,410

[1]Plant Operating at above rate for 7972 HRS/YR.

TRACE ELEMENT MASS BALANCE

ELEMENT	COAL		ASH			GAS LIQUOR			TAR			OIL			% BAL-ANCE
	ppm [2]	g/t coal [1]	ppm	mg/t coal	% distr	ppm	mg/t coal	% distr	ppm	mg/t coal	% distr	ppm	mg/t coal	% distr	
Lithium	20	13.1	60	4.35	33	0.02	0.02	0.2	5	0.18	1.4	0.5	0.004	-	35
Beryllium	2.0	1.3	5	0.36	28	0.008	0.008	0.6	0.1	0.003	0.2	0.05	0.0004	-	29
Boron	300	197	>1500	109	55	3	3.0	1.5	20	0.73	0.4	30	0.24	0.1	57
Fluorine	24	15.8	230	16.7	106	0.5	0.5	3.2	12	0.44	2.8	0.06	0.0005	-	112
Vanadium	10	6.6	70	5.1	77	0.003	0.003	-	0.05	0.002	-	0.15	0.001	-	77
Chromium	6	3.9	40	2.9	74	<0.03	0.03	0.8	1	0.04	0.9	0.6	0.005	0.1	76
Cobalt	2	1.3	10	0.73	56	<0.03	0.03	2	0.05	0.002	0.2	0.02	0.0002	-	59
Nickel	3	2.0	25	1.8	91	<0.2	0.2	10	10	0.37	18	1.5	0.01	0.6	120
Copper	5	3.3	50	3.6	109	0.3	0.3	9	0.1	0.004	-	2	0.01	0.3	118
Zinc	0.6	0.4	0.5	0.04	10	0.4	0.4	100	6	0.2	50	0.4	0.003	0.8	161
Arsenic	30	19.7	60	4.3	22	3	3	15	2	0.07	0.4	1.7	0.01	-	39
Selenium	1	0.66	1.5	0.11	16	2	2	303	0.2	0.007	1	<0.01	-	-	320
Molybdenum	0.5	0.33	4	0.29	88	<0.2	0.2	61	0.02	0.0007	0.2	0.02	0.0001	-	149
Silver	0.1	0.066	0.7	0.05	77	<0.2	0.2	303	<0.2	0.007	11	<1	0.008	12	403
Cadmium	<0.1	0.066	<1	0.07	106	<0.03	0.03	45	<0.1	0.004	5	<0.1	-	-	156
Tin	4	2.63	12	0.87	33	<0.03	0.03	1	0.2	0.007	0.3	<0.05	-	-	34
Antimony	0.1	0.066	1	0.07	110	<0.03	0.03	45	<0.05	0.002	3	<0.02	-	-	158
Barium	2500	1642	1.2%	870	53	-	-	-	15	0.55	-	0.5	0.004	-	53
Mercury	0.05	0.033	<0.1	0.007	22	<0.03	0.03	91	<0.1	0.003	11	<0.1	0.0008	2.4	126
Lead	20	13.1	200	14.5	111	0.2	0.2	1.5	1.5	0.055	0.4	0.15	0.001	-	113
Thorium	1	0.66	6	0.43	66	-	-	-	2	0.07	11	<1	0.008	1	78
Uranium	1	0.66	6	0.43	66	<0.2	0.2	30	5	0.18	28	<1	0.008	1	125

[1] Grams/metric ton (wet)

[2] Parts per million (dry)

Energy Balance (MM Btu/D)

Gasification Efficiency (based on HHV)

Input		
Coal to Gasifier	(27,272)(2,000)(7,230)	= 394,400
Output		
SNG	(275) (997)	= 268,700
Tar, Oils, Naphtha		41,900
Phenols		4,500
Ammonia		4,200
Stretford Off Gas		14,500
Total		338,800
Efficiency	$\frac{338,800}{394,400}$ 100 = 84.6%	

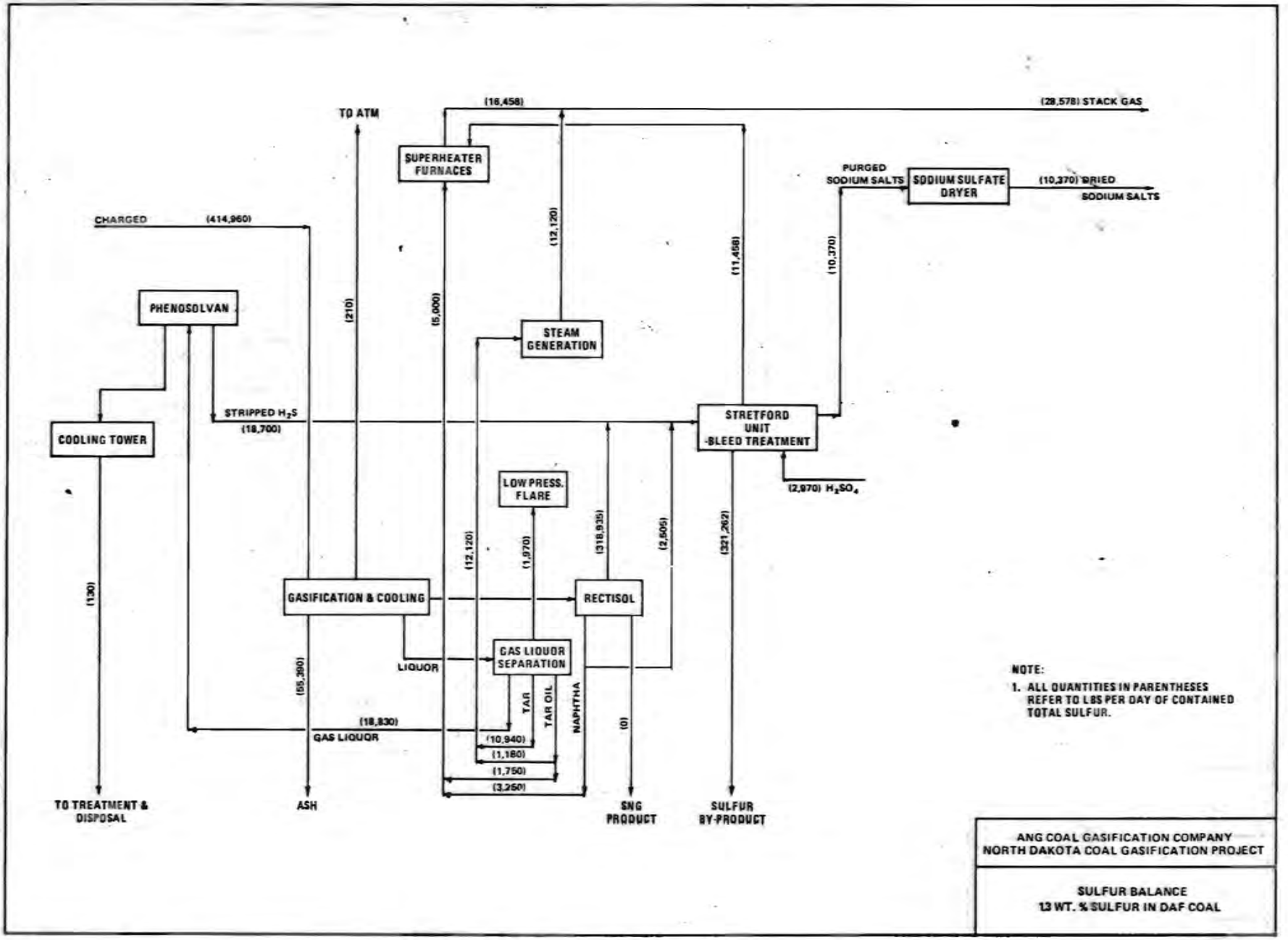
Overall Efficiency

Input	
Coal to Gasifier	394,400
Electric Power - Plant (3.25 MM KWH/D)	11,100
Electric Power - Mine (0.16 MM KWH/D)	600
Vehicles (7×10^6 gallons/yr @ 150 M Btu/gal)	2,900
Total	409,000
Output	
SNG	268,700
Ammonia	4,200
Total	272,900
Efficiency	$\frac{272,900}{409,000}$ 100 = 66.7%

POLLUTANT EMISSIONS AND ABATEMENT (lbs/hr)

Item	Pollution Control	SO_2 (7)	NO_x	Non-Methane Hydro-Carbons	Particu-lates	COS	CO	H_2S	% Removal Efficiency
Coal Lock Ejector	Low Energy Scrubber	-	-	-	Trace	0.5	380	11.5	N.D. (4)
Ash Lock Fan	Low Energy Scrubber	-	-	-	Trace	-	-	-	N.D.
Start-up Incinerator (1) (Intermittent)	None	1,150	-	-	-	-	-	-	-
Flare (2) (Intermittent)	None	18,090	-	-	-	-	-	-	-
Steam Boilers	Hot. El. Stat. Prec.	1,010	780	60	130	-	110	-	80%
Steam Superheater	None	1,595	320	30	40	-	250	-	-
Stretford Plant (6)	Incineration	-	-	-	-	-	-	-	99% (5)
Shift Catalyst Regeneration (3) (Intermittent)	None	2,750	-	-	-	-	-	-	-
Gas Liquor Vent Gas (2)	Low Pressure Flare	219	-	-	-	-	-	-	-
Coal Handling:									
Primary Crusher Stn.	Baghouse	-	-	-	9.4	-	-	-	N.D.
Sec. Crusher Station	Baghouse	-	-	-	13.4	-	-	-	N.D.
Belt Conveyor Transfer & Sampling Station	Baghouse	-	-	-	10.6	-	-	-	N.D.
Fine Screening & Crus. Station	Baghouse	-	-	-	11.7	-	-	-	N.D.
Belt Conveyor Transfer Station	Baghouse	-	-	-	2.7	-	-	-	N.D.
Fines Storage Silo & Belt Conveyor Transfer Station	Baghouse	-	-	-	1.5	-	-	-	N.D.
Gasifier Building	Baghouse	-	-	-	28.5	-	-	-	-
Belt Conveyor Transfer & Sampling Station	Baghouse	-	-	-	13.4	-	-	-	-
Live Storage Reclaim Tunnel Ventilation	None	-	-	-	2.3	-	-	-	-
Ash Handling:									
Ash Dewatering Vent	None	-	-	-	-	-	-	-	-
Ash Dewatering Clarifier	None	-	-	-	-	-	-	-	-
Refuse Incineration	Scrubber	-	-	-	N.D.	-	-	-	N.D.

(1) Maximum case, start-up of 5 gasifiers 3 on air, 2 on oxygen.
(2) Maximum case during upset conditions.
(3) During Catalyst Regeneration Only, maximum case, 1.5% of total operating time.
(4) Not determined.
(5) H_2S Removal Efficiency.
(6) The Stretford off gases are incinerated in the superheater and account for approximately 1200 lb/hr of the SO_2 emissions from the superheater.
(7) Based on 1.7 wt. % sulfur in DAF coal.


TO ATM
(16,458)
(28,578) STACK GAS
SUPERHEATER FURNACES
PURGED SODIUM SALTS
SODIUM SULFATE DRYER
(10,370) DRIED SODIUM SALTS
CHARGED
(414,960)
(12,120)
(11,458)
(10,370)
PHENOSOLVAN
(210)
(5,000)
STEAM GENERATION
STRIPPED H_2S
(18,700)
COOLING TOWER
STRETFORD UNIT -BLEED TREATMENT
(2,970) H_2SO_4
LOW PRESS. FLARE
(1,970)
(318,935)
(2,505)
(321,262)
(130)
GASIFICATION & COOLING
RECTISOL
(12,120)
GAS LIQUOR SEPARATION
LIQUOR
(55,390)
TAR
TAR OIL
NAPHTHA
(0)
(18,830)
GAS LIQUOR
(10,940)
(1,180)
(1,750)
(3,250)
TO TREATMENT & DISPOSAL
ASH
SNG PRODUCT
SULFUR BY-PRODUCT
NOTE:
1. ALL QUANTITIES IN PARENTHESES REFER TO LBS PER DAY OF CONTAINED TOTAL SULFUR.
ANG COAL GASIFICATION COMPANY
NORTH DAKOTA COAL GASIFICATION PROJECT
SULFUR BALANCE
13 WT. % SULFUR IN DAF COAL

ATTACHMENT

Environmental Control
Division of
Environmental Engineering
MISSOURI OFFICE BUILDING
1200 MISSOURI AVENUE
BISMARCK, NORTH DAKOTA
58505

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DIRECTOR
(701) 224-2348

North Dakota State

Department of Health

JONATHAN B. WEISBUCH, M.D.
STATE HEALTH OFFICER

W. VAN HEUVELEN, CHIEF
ENVIRONMENTAL CONTROL

April 13, 1977

Mr. Gary N. Weinreich
Environmental Coordinator
Synthetic Fuels
American Natural Gas Service Company
One Woodward Avenue
Detroit, Michigan 48226

Re: December 17, 1976 Request for Interpretation of Applicability of Regulation R23-25-12, New Source Performance Standards, for Proposed Coal Gasification Plant

Dear Mr. Weinreich:

This Department has reviewed your December 17, 1976 request for interpretation of the applicability of Regulation R23-25-12, New Source Performance Standards, as it pertains to sulfur dioxide and nitrogen oxides emissions from the steam boilers and steam superheaters of your proposed coal gasification plant.

Two interpretations are requested in your December 17, 1976 letter. The first interpretation requests that the sulfur dioxide (SO_2) resulting from the incineration of Stretford unit off-gas in the steam superheaters be exempt from the 0.8 pounds SO_2 per million BTU heat input emission standard of Section 12.401 (4)(a)(i) of Regulation R23-25-12 for liquid fossil fuel-fired steam generators and that only the sulfur dioxide resulting from the burning of the liquid fuels be subject to the standard.

The second interpretation requests that the steam boilers and steam superheaters be exempt from the nitrogen oxides (NO_x) emission standards of Section 12.401 (5)(a) of Regulation R23-25-12 for fossil fuel-fired steam generators burning gaseous, liquid or solid fossil fuels either individually or simultaneous in any combination.

With respect to the sulfur dioxide (SO_2) emission standard of Section 12.401 (4)(a)(i) of Regulation R23-25-12, the Department has determined that the Stretford unit off-gas burned in the steam superheaters would not be subject to the 0.8 pound per million BTU heat input standard. This is because the off-gas is a waste byproduct not produced for the purpose of generating useful heat. Therefore the off-gas is not a fossil fuel as defined in Section 12.401 (2)(b) of Regulation R23-25-12.

The monitoring of the total sulfur content and quantity of the off-gas stream before it is incinerated in the steam superheaters will be required so that compliance with the 0.8 lbs $SO_2/10^6$ BTU heat input standard for the burning of the liquid fuel can be adequately determined as required by Section 12.401 (6)(b) of Regulation R23-25-12. This requirement will be included as condition to a permit to construct, upon issuance.

The emissions of sulfur dioxide from a coal gasification plant are regulated by Regulation R23-25-15, Prevention of Significant Deterioration of Air Qulaity. This regulation requires that best available control technology be applied to control sulfur dioxide emissions not subject to a New Source Performance Standard as is the case for the Stretford unit off-gas.

The Department would require the submission of a detailed discussion, with supporting evidence, of why you feel that your present design of a Stretford unit plus incineration is the best available control technology for controlling SO_2 emissions from the gasification portion of the plant. Upon review and approval of the information submitted, the Department will specify an SO_2 emission limit for the Stretford off-gas as per Section 15.102 (2)(b)(ii) of Regulation R23-25-15. This limit will be included as condition of a permit to construct, upon issuance.

With respect to the nitrogen oxides (NO_x) emission standards of Section 12.401 (5)(a) of Regulation R23-25-12, the Department has determined that the steam boilers and the steam superheaters should be exempt from these standards. The Stretford unit off-gas, to be burned in the steam superheaters, would not be subject to the NO_x standards as it is a waste byproduct not produced for the purpose of generating useful heat. Therefore it is not a fossil fuel as defined in Section 12.401 (2)(b) of Regulation R23-25-12. The liquid fuels (tars, tar oils, naphtha and phenols) to be burned in the steam boilers and steam superheaters are byproduct fuels derived from the lignite gasification process. The best available control technology required to meet the 0.3 pound NO_x per million BTU heat input emission standard for liquid fuels of Section 12.401 (5)(a)(ii) consists of well designed low NO_x emission burners, which reduce the peak flame temperature, and remove oxygen from the volatilization zone. Because the liquid fuels contain a high nitrogen and oxygen content, the application of this control technology would result in 0.557 pound NO_x per million BTU heat input compared to the 0.3 pound NO_x per million BTU heat input allowed. Laboratory attempts to reduce the nitrogen and oxygen content of the liquid fuels prior to burning have been unsuccessful. It is the policy that a fuel should be subject to a New Source Performance Standard if, and only if, there is evidence that the general type of control equipment on which the standard was based can be used to meet the standard for the fuel in question, or that the standard was intended to preclude use of such fuel. Since the NO_x standard for liquid fuels

was based on control techniques which will not reduce NO_x emissions for these byproduct liquid fuels and since there is no evidence that indicates that these fuels should be precluded from use; it would appear appropriate that the steam boilers and steam superheaters be exempted from meeting the NO_x emission limits specified in Section 12.401 (5)(a) of Regulation R23-25-12.

The Department would require the submission of a detailed discussion with supporting evidence that the best available control technology has been employed in the design of the steam boilers and steam superheaters for NO_x control and that the emission rate of 0.557 pounds NO_x per million BTU heat input for liquid fuels burned in the steam boilers and the emission rate of 0.24 pounds NO_x per million BTU heat input for the liquid fuels and the Stretford off-gas burned in combination in the steam superheaters are the lowest emission rates for NO_x control achievable with present best available control technology. Upon review and approval of the information submitted, the Department will specify NO_x emission limits and NO_x monitoring requirements for the steam boilers and steam superheaters. These limits will be included as conditions to a permit to construct, upon issuance.

The information requested above should be submitted as soon as possible so the appropriate emission limit conditions for SO_2 and NO_x can be drafted and the processing of your permit to construct will not be delayed.

If you have any questions concerning this letter, please feel free to contact this office.

Yours truly,

W. Van Heuvelen, Chief
Environmental Control

WVH/DKM:lrr
cc: John Dale, EPA

Appendix C

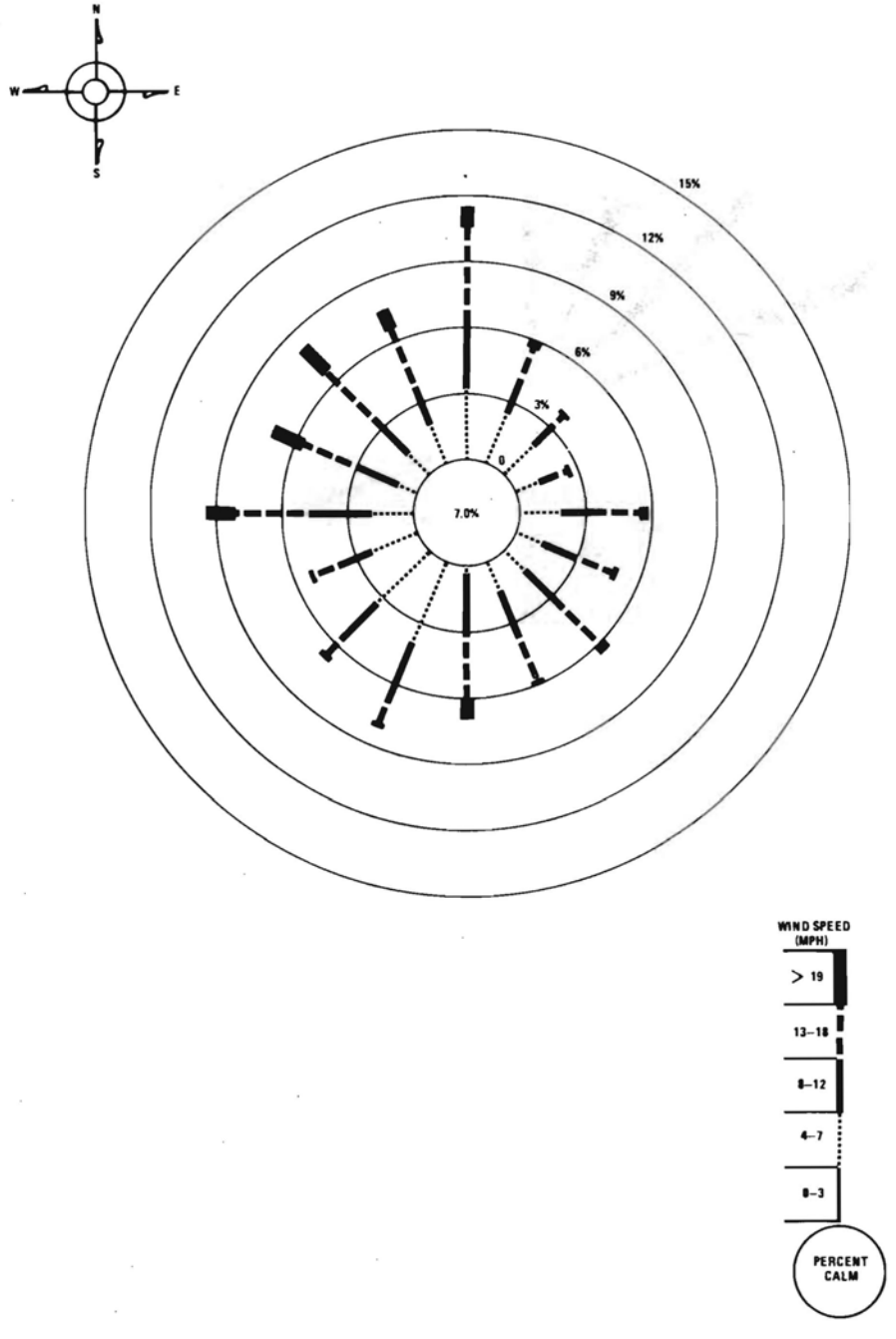
Environmental Studies

ENVIRONMENTAL STUDIES OF PROPOSED PLANT AND ASSOCIATED SYSTEMS

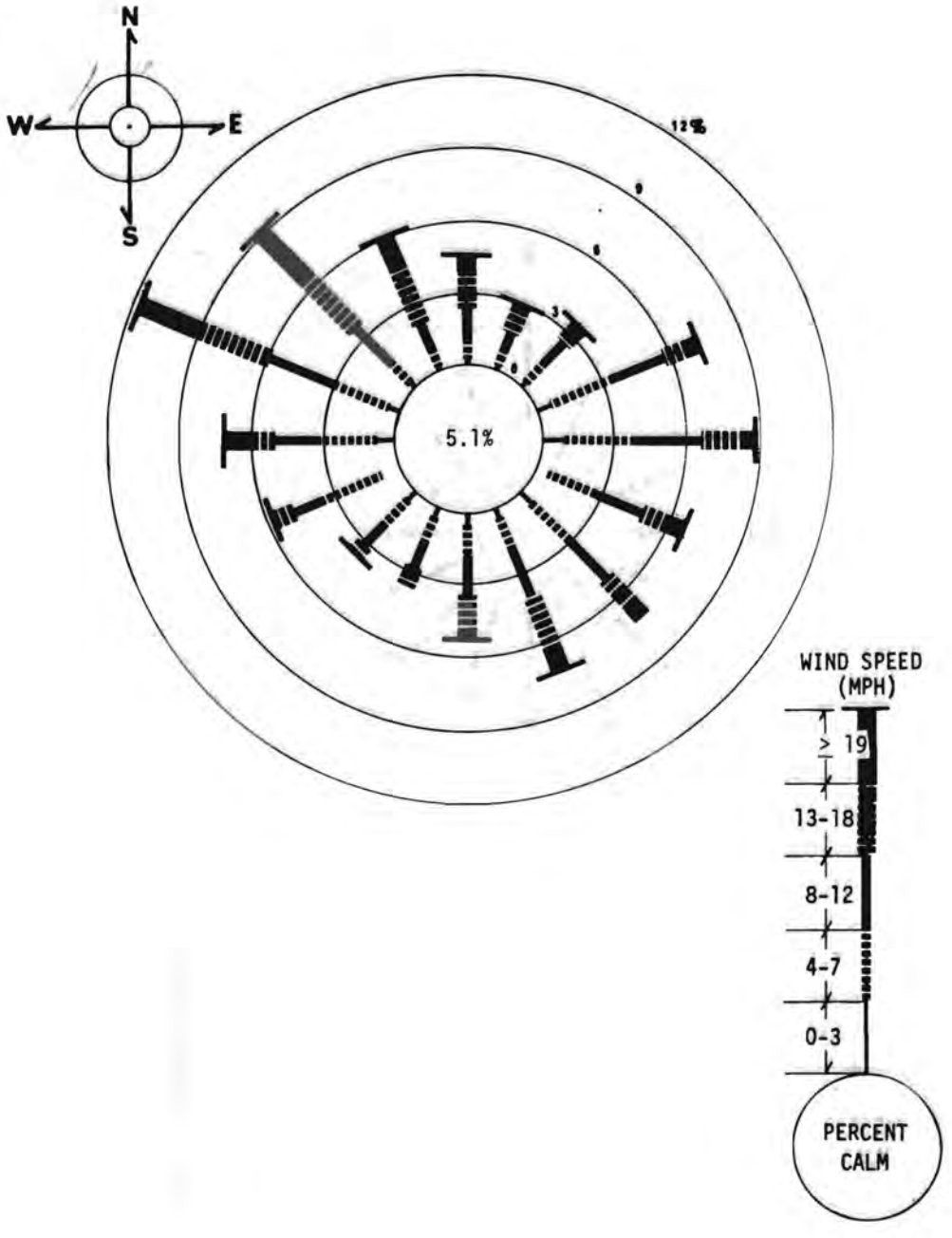
Title of Study	Organization	Frequency of Study	Reporting Schedule	Completion Date
Environmental Geologic Investigation	Woodward-Thorfinnson & Assoc.	Once	Final Report	July 1974
Environmental Soil Survey	Woodward-Thorfinnson & Assoc.	Once	Final Report	August 1974
Archaeological/Historical Assessment	Woolworth Research Assoc.	Once	Final Report	August 1974
Detailed Environmental Analysis of Gasification Plant and Mining Sites	Woodward-Clyde Consultants	Once	Final Report	March 1975
Detailed Environmental Analysis of Product Pipeline Route	Ecology and Environment, Inc.	Once	Final Report	March 1975
Environmental Impact Narrative for Water Intake and Pipeline	Environmental Engineering	Once	Final Report	April 1975
Environmental Impact Analysis of Railroad Spur	ANG	Once	Final Report	May 1976
Noise and Odor Monitoring	ANG	Continuing	Annual	Duration of plant and mining
Air and Water Quality Monitoring	ANG	Continuing	Annual	Duration of plant and mining
Biotic Community Monitoring	ANG	Continuing	Annual	Duration of reclamation

Appendix D

Annual Wind Roses for Williston and Bismarck
North Dakota Air Quality Data
Plant Site SO_2, Sulfation, Suspended Particulates, and Dustfall Data



ANNUAL PERCENTAGE FREQUENCY OF WIND SPEED AND DIRECTION
WILLISTON, NORTH DAKOTA, 1964 THROUGH 1975



ANNUAL PERCENTAGE FREQUENCY OF WIND SPEED AND DIRECTION,
BISMARCK, NORTH DAKOTA, 1955 THROUGH 1964

SUMMARY OF AIR QUALITY MEASUREMENTS FROM BISMARCK, MANDAN, AND DICKINSON, NORTH DAKOTA, 1970-1974

	Suspended Particulates		Suspended Sulfates		Reactive Sulfur (Sulfation)		Dustfall		Coefficient of Haze
	Annual Geometric Mean ($\mu g/m^3$)	Maximum 24-hour Sample ($\mu g/m^3$)	Annual Average ($\mu g/m^3$)	Maximum 24-hour Sample ($\mu g/m^3$)	Annual Average (mg/100 cm^2/day)	Maximum 1-Month Sample (mg/100 cm^2/day)	Annual Average (tons/mi^2)	Maximum 3-Month Sample (tons/mi^2)	Annual Geometric Mean (coh/1000 ft)
Bismarck									
1970	68	136	2.80	8.30	0.16	-	8.1	11.8	NA[2]
1971	55	147	3.92	7.70	0.09	0.16	4.8	7.7	0.21
1972	59	406	3.63	10.43	0.12	0.25	5.7	8.3	0.18
1973	53	158	4.30	10.46	0.10	0.22	4.6	11.9	0.06
1974[1]	-[3]	132	-	6.17	-	0.22	-	14.0	-
Mandan									
1970	42	83	3.20	5.40	<.1	<.1	NA	NA	NA
1971	52	100	3.99	8.12	0.09	0.26	NA	NA	NA
1972	42	112	3.48	12.00	0.12	0.26	NA	NA	NA
1973	41	116	3.56	7.60	0.10	0.16	NA	NA	NA
1974[1]	-	98	-	3.72	-	0.23	+	+	+
Dickinson									
1970	46	126	1.70	6.20	NA	NA	NA	NA	NA
1971	41	98	2.08	3.90	0.05	0.10	NA	NA	NA
1972	42	105	2.60	5.51	0.05	0.09	NA	NA	NA
1973	49	149	3.66	24.26	0.07	0.17	NA	NA	NA
1974	-	156	-	2.45	-	0.11	+	+	+

[1] 1974 Data indicates data through June 1974
[2] No measurements available
[3] Not yet available
Source: Woodward-Envicon, Inc. 1974.

MEASURED SO_2 CONCENTRATIONS, PERCENT FREQUENCY OF OCCURRENCE, 16 JUNE, 1974 THROUGH 14 AUGUST, 1974

PPM	24 Hour Average No. Obs.	24 Hour Average % Occurrence	1 Hour Average No. Obs.	1 Hour Average % Occurrence
.000 - .005	6	11.1%	204	15.7%
.006 - .010	6	11.1	189	14.6
.011 - .015	5	9.3	180	13.9
.016 - .020	7	13.0	136	10.5
.021 - .025	7	13.0	96	7.4
.026 - .030	7	13.0	103	7.9
.031 - .035	5	9.3	103	7.9
.036 - .040	3	5.6	57	4.4
.041 - .045	4	7.4	47	3.6
.046 - .050	3	5.6	53	4.1
.051 - .055			27	2.1
.056 - .060			24	1.9
.061 - .065	1	1.9	18	1.4
.066 - .070	54		11	0.9
.071 - .075	Max. = .063 ppm		19	1.5
.076 - .080			9	0.7
.081 - .085			5	0.4
.086 - .090			5	0.4
.091 - .095			7	0.5
.096 - .100			2	0.2
.101 - .105			1	0.1
			1296	

Source: Woodward-Envicon, Inc., 1974.

SULFATION DATA FROM PASSIVE DEVICES - 1974 (REACTIVE SULFUR) MILLIGRAMS/100 CM^2/DAY

STATION No.	Elev. (Ft-AGL)	2/23/74 3/14/74 (Mar)	3/14/74 4/13/74 (Apr)	4/13/74 5/15/74 (May)	4/23/74 5/23/74 (May)	5/15/74 6/13/74 (Jun)	5/23/74 6/24/74 (Jun)	6/24/74 7/24/74 (Jul)	Arith-metic Avg.
GENERAL PLANT AREA NETWORK PERIOD									
1	(10)						<.13	<.13	<.13
2	(10)						<.13	<.13	<.13
3	(10)	<.20	<.14	<.13	+	<.14	Δ	<.13	<.15
4	(10)						+	<.13	<.13
5	(10)						<.13	<.13	<.13
6	(10)						<.13	<.13	<.13
7	(10)						<.13	<.13	<.13
8	(10)						<.13	<.13	<.13
9	(10)						<.13	<.13	<.13
10	(100)	-	<.14	<.13	+	<.14	+	<.13	<.13

STATION NAME	(Mar) 1974	(Apr) 1974	(May) 1974	(May) 1974	(Jun) 1974	(Jun) 1974	(Jul)* 1974
NORTH DAKOTA STATE NETWORK PERIOD							
Bismarck	0.22	0.16	0.14	0.14	0.12	0.12	
Dickinson	0.11	0.10	0.05	0.05	N.D.	N.D.	
Williston	0.08	0.18	0.06	0.06	0.02	0.02	

+ = Data invalid
- = Station not yet activated
Δ = Different sample period
N.D. = No Data
* = Data not available

Compiled by: Woodward-Envicon, Inc. 1974.

RESULTS OF ANALYSIS OF HI-VOL SAMPLES FOR SUSPENDED PARTICULATES, METEOROLOGICAL TEST SITE AND NORTH DAKOTA STATE AIR QUALITY NETWORK

Location	Meteorological Test Site			Arithmetic Averages ($\mu g/m^3$) North Dakota State Air Quality Network									
Period	June & July 1974			June & July 1972			June & July 1973			June 1974			
Element	Max.	Min.	Avg.	Fox.	Dic.	Bis.	Fox.	Dic.	Bis.	Fox.	Dic.	Bis.	Bes.
Sulfates ($\mu g/m^3$)	4.90	0.49	3.19	2.06	1.73	4.02	4.41	1.97	3.77	0.61	1.10	1.43	1.44
Nitrates ($\mu g/m^3$)	0.64	0.33	0.39	0.94	1.01	1.53	2.28	0.94	2.13	0.39	0.48	0.74	1.59
Fluorides ($\mu g/m^3$)	.022	.003	.009	.009	.003	.015	.034	-	-	0.01	0.01	0.02	0.03
pH	5.6	9.2	9.4	9.38	9.38	9.38	8.59	8.64	8.87	7.00	7.11	7.22	7.78
Trace Metals ($\mu g/m^3$)													
(Mercury)	<0.0003												
(Arsenic)	<0.0042												
(Molybdenum)	<0.017												
(Selenium)	<0.083												
(Lead)	<0.041												
(Antimony)	<0.025												
(Beryllium)	<0.0015												
(Cadmium)	0.0			No trace metals analyses performed									
(Vanadium)	<0.003												
(Manganese)	0.060												
(Chromium)	0.003												
(Copper)	0.114												
(Nickel)	0.011												
(Zinc)	0.049												
(Iron)	1.50												
(Barium)	0.0												
(Boron)	0.0												
Radionuclides (pci/m^3)													
Alpha	0.002 ± 0.001			-	-	-	-	-	-	-	-	-	-
Beta	0.339 ± 0.022			0.25	.201	.271	0.09	.039	.046	0.41	0.32	0.37	0.35

Legend: Fox (Foxholm, North Dakota)
Dic (Dickinson, North Dakota)
Bis (Bismarck, North Dakota)

- No values during period

Source: Woodward-Envicon, Inc., 1974.

RESULTS OF DUSTFALL ANALYSIS CONCENTRATIONS (TONS/MI^2/MONTH)

Station		General Plant Network Periods								
No.	Elev. (Ft-AGL)	2/23/74 3/14/74 (Mar)	3/14/74 4/13/74 (Apr)	4/13/74 5/15/75 (May)	4/23/74 5/23/74 (May)	5/15/74 6/13/74 (Jun)	5/23/74 6/24/74 (Jun)	6/13/74 7/15/74 (Jul)	6/24/74 7/24/74 (Jul)	Arithmetic Mean
1	(10)	-	-	-	2.918	Δ	4.659	Δ	6.432	4.67
2	(10)	-	-	-	1.473	Δ	5.162	Δ	18.589	8.41
3	(10)	0.533	2.024	1.412	Δ	3.201	Δ	4.328	Δ	2.30
4	(10)	-	-	-	2.401	Δ	5.744	Δ	34.136	14.43
5	(10)	-	-	-	3.372	Δ	3.340	Δ	4.140	3.62
6	(10)	-	-	-	14.370	Δ	13.319	Δ	12.705	13.47
7	(10)	-	-	-	2.495	Δ	6.447	Δ	6.527	5.16
8	(10)	-	-	-	3.937	Δ	3.888	Δ	8.691	5.51
9	(10)	-	-	-	2.932	Δ	3.452	Δ	12.956	6.45
10	(100)	-	1.914	1.741	Δ	2.196	Δ	2.541	Δ	2.1c

Station	North Dakota State Network Periods								
Name	(Mar)	(Apr)	(May)	(May)	(Jun)	(Jun)	(Jul)	(Jul)	Arithmetic Mean
Bismarck 1974	4.7	14.7	Δ	12.2	Δ	7.7	Δ	N.D.	9.83
Bismarck 1973	11.9	5.5	Δ	3.0	Δ	1.2	Δ	7.2	5.76
Bismarck 1972	3.6	10.6	Δ	8.3	Δ	8.0	Δ	6.9	7.08

- = Station not yet activated.
Δ = Different sample period.
N.D. = No data

Source: Woodward-Envicon, Inc. 1974.
North Dakota Department of Health.

Appendix E

Water Inventory and Quality Data

GROUNDWATER AND SPRING INVENTORY DATA

Well No.	Elevation (ft MSL)	Owner	Use	Depth (ft)	Diam (in)	Casing Depth (ft)	Pump-type	Aquifer	Water Bearing Material	Location
G01	1855	NDSWC		229.82	-	-	-	OW	SG	146/88/21DDD
G02	1890T	A. Cristman	S	35.75	18	-	R	SB	L	146/88/22CBB1
G03	1774T	F. Hoffman	D	940R	2	-	N	HC-L?	-	144/86/9DCB
G04	2060T	WMAI	T	129.9	2	-	N	SB	L	145/87/18BAA
G05	1735	NDSWC	U	224	1	-	N	OW	G	144/86/19ABA
G06	1775	NDSWC	U	156	1	-	N	OW	G	144/88/25CCC3
G07	1770	NDSWC	U	103.6	1	-	N	OW	S	144/88/36BBC2
G08	1790	NDSWC	U	85.45	1	-	N	OW	GS	144/88/31BCC
G09	2015	WMAI	T	103.0	2	97.5R	N	SB	L	145/87/30AD8
G10	1925T	Eisenbeis	D&S	155	4	115R	W,R	OW	G	145/88/3ACC
G11	1830T	B. Dschaak	D	56.5	4	-	E	AL or OW	-	144/89/14DC3
G12	1875T	E. Beick	D&S	24.5	48	-	P	SB	L	144/89/24BCC
G13	2080	WMAI	T	23.8	2	-	N	AL	S	145/87/2E-1/4
G14	2010	WMAI	T	87.7	2	85.2	N	SB	L	145/87/11DDD
G15	1079	WMAI	T	113.2	2	110.7	N	SB	L	146/87/22S 1/4
G16	2100	WMAI	T	160.7	2	158.2	N	SB	L	146/87/27ctr
G17	1910	NDSWC	U	198.8	1	210R	N	OW	S	145/88/25A8B
G18	2060T	WMAI	T	188.4	-	185.9	N	SB-TR	L	146/87/28ADD
G19	1900T	H. Boeckel	S	23.6	24	-	W,P	OW?	C	145/87/30CCA
G20	2185T	WMAI	T	212.8	2	215.3	N	SB-TR	L	145/86/6CB8
G21	2040T	WMAI	T	206.2	2	203.7	N	SB-TR	L	145/87/19BBC
G22	1862	NDSWC	U	16.82	1	46	N	OW?	S	145/87/32DC
G23	2070	WMAI	T	135.3	2	132.8	N	SB	C,L	146/87/21S-1/4
G24	1990	WMAI	T	43.7	2	41.2	N	SB	L	145/87/26ABA
G25	2030	WMAI	T	114.8	2	112.3	N	SB	L	145/87/19CCB
G26	2030	WMAI	T	53.2	2	50.7	N	SB	CS	145/87/19CBD
G28	1760	NDSWC	U	230	1	-	N	OW	S	144/87/14AAA
G29	1820	Knoell	U	15.8	-	-	-	AL? OW?	-	144/87/3A
G30	1748T	Weigum	-	-	-	-	-	OW?	-	144/86/18ABA
G34	1741	NDSWC	U	62.5	1	-	N	AL	S	144/86/18ADC2
G38	1740T	NDSWC	U	164.2	1	-	N	OW	GS	144/86/18DAB
G45	1736	NDSWC	U	203.5	1	-	N	OW	GS	144/86/18DDC4
G46	1795T	-	-	27	-	-	-	OW	-	143/88/4DCD
G57	1930T	T. Teske	S	33.5	24	-	R	SB	L	145/87/28CDD
G58	1763T	E. Oster	U	18.3	36	-	N	AL	-	144/87/14AA1
G60	1840	NDSWC	U	225.4	1	-	N	OW	S	144/88/17BCD
G61	1950T	D. Boeckel	-	40R	24	-	W,P	SB?	-	145/87/30ABB
G65	1950T	C. Boeckel	D	45	6	-	E	SB	-	145/88/23DDB2
G73	2063T	E. Boeckel	D&S	1370R	4- 400' 2-1,370'	-	R	HC-FH	-	145/87/6CBB3
G77	2020T	H. Hafner	D	320R	4	-	R	SB-TR	L	146/87/17DDD2
G78	1915	H. Hafner	D	1205R	2	-	F	HC-FH	S	146/87/8DDD2
G79	1940T	M. Hafner	S	1299R	2	-	F	HC-FH	S	146/87/10DBC
G81	1995T	E. Richter	D&S	72.3	4	-	E	SB	L	145/86/11CDD
G89	1820T	F. Oat	D	147R	4	-	E	TR?	L	144/88/26AA1
G91	1930T	W. Rahn	S	68.5	24	-	P	SB	L	145/86/35CCA1
G92	1730T	L. Sailer	S	41.50	4	-	E	OW	-	144/86/8DDD1
G93	1732	F. Hoffman	S	730R	2	-	N	HC-L	S	144/86/17AD
G96	1790T	B. Schwarz	D	28	24	-	R	OW orAL	S	144/87/25ADC2
G98	2100E	Schlender	S	52.85	6	-	R	SB	-	145/89/22BB2
F01	1889	R. Sailer	D&S	-	-	-	-	SB?	L	146/88/28DAC
F02	1860T	J. Sailer	S	-	-	-	-	-	-	145/87/33DCA1
F03	1980T	E. Keller	S	-	-	-	-	-	-	145/88/12DCD4
F04	2140T	R. Knecht	S	-	-	-	-	-	-	146/86/31DDA
F05	2100E	Mittel-Steadt	S	6.16	48	-	N	-	-	145/89/31BBC
I80	1870T	Weidner	D&S	210R	6	-	R	SB	-	146/87/18CCA
I87	2100E	H. Buechler	S	48.65	18	-	R	SB?	C	145/89/22ABB2
I88	2100E	Schlender	U	28.33	36	-	R	SB?	-	145/89/22BB
I99	1890T	A. Christman	D	36	6	-	E	SB	-	146/88/22CBB2

KEY TO ABBREVIATIONS

Elevation - T - from Topographic map
E - estimated

Owner NDSWC - North Dakota State Watgr Commission
- North Dakota Geology Survey

Use D - domestic
S - stock
T - test
U - unused

Depth, Casing Depth
R - reported

Pump Type - E - electric
F - flow valve
P - pitcher
R - red jacket
W - windmill

M.P. - measuring point
B - at or above basement floor

LSD - land surface datum

Aquifer AL - alluvium
OW - outwash
SB - Sentinel Butte
TR - Tongue River
L - Cannonball-Ludlow
HC - Hell Creek
FH - Fox Hills
P - perched

Water Bearing Material
C - clay
CS - clayey sand
GS - gravelly sand
SG - sandy gravel
L - lignite
G - gravel
S - sand

Location 145/ - Township North
/87/ - Range West
/10ACB - Section, ¼, ¼ of ¼, ¼ of ¼ of ¼
A - northeast
B - northwest
C - southwest
D - southeast

Source: North Dakota Geological Survey, Bulletin 56, Part II, 1970.
Woodward-Envicon, Inc. Analysis, 1974.

RENNER BAY, - WATER QUALITY DATA,
28 JUNE, 1974 THROUGH 26 SEPTEMBER, 1974 1/

Parameter	Date	Location LO1	LO2	LO3	LO4	LO5	Mean ± Deviation without LO5
Biochemical Oxygen Demand, mg/l	6/28	0.7	0.5	0.8	0.5	0.7	0.6 ± 0.2
	7/22	0.5	0.4	0.3	0.4	0.8	0.4 ± 0.1
	8/23	0.3	0.2	0.4	0.4	0.9	0.3 ± 0.1
	9/26	0.4	0.3	0.6	0.5	0.5	0.5 ± 0.1
Chemical Oxygen Demand, mg/l	6/28	11.0	11.0	8.6	7.4	8.2	9.5 ± 1.8
	7/22	10.6	11.0	15.0	11.0	15.0	11.9 ± 2.1
	8/23	6.1	8.8	8.6	8.3	10.4	8.0 ± 1.1
	9/26	8.6	9.1	14.4	11.9	11.9	11.1 ± 2.6
Total Hardness mg/l (as $CaCO_3$)	6/28	236	236	237	235	240	236 ± 1
	7/22	212	213	214	214	216	213 ± 1
	8/23	208	208	208	208	219	208 ± 0
	9/26	204	204	204	204	206	204 ± 0
Sulfate, mg/l	6/28	128	112	123	117	115	120 ± 7
	7/22	132	125	123	130	124	127 ± 4
	8/23	115	116	117	120	121	117 ± 2
	9/26	167	168	166	163	169	166 ± 2
Chloride, mg/l	6/28	9.5	9.3	9.5	9.7	9.5	9.5 ± 0.2
	7/22	10.4	10.4	10.4	10.4	10.4	10.4 ± 0
	8/23	9.9	9.9	10.2	9.9	10.0	10.0 ± 0.2
	9/26	9.4	9.4	9.4	9.4	9.4	9.4 ± 0
Total Solids, mg/l	6/28	438	440	438	474	482	448 ± 18
	7/22	470	518	476	476	478	485 ± 22
	8/23	430	428	430	478	492	441 ± 28
	9/26	444	446	476	442	468	452 ± 16
Total Dissolved Solids, mg/l	6/28	436	439	436	473	474	452 ± 20
	7/22	458	514	472	468	475	478 ± 25
	8/23	428	422	428	476	414	439 ± 25
	9/26	442	444	474	440	466	450 ± 16
Total Volatile Solids, mg/l	6/28	104	108	106	100	112	105 ± 3
	7/22	90	162	216	152	138	155 ± 52
	8/23	218	184	200	238	110	210 ± 23
	9/26	76	94	90	96	110	89 ± 9
Total Alkalinity, mg/l (as $CaCO_3$)	6/28	164	168	164	160	168	164 ± 3
	7/22	165	166	167	164	170	166 ± 1
	8/23	164	164	164	164	174	164 ± 0
	9/26	166	164	165	168	168	166 ± 2
Apparent Color Pt-Co units	6/28	7	6	9	9	9	8 ± 2
	7/22	7	8	8	7	7	8 ± 1
	8/23	9	7	8	9	10	8 ± 1
	9/26	9	9	9	9	9	9 ± 0
Turbidity, FTU	6/28	0.7	0.7	0.9	0.7	0.2	0.8 ± 1
	7/22	2.5	2.0	1.9	2.1	1.6	2.1 ± 0.3
	8/23	2.3	2.6	2.4	2.2	1.5	2.4 ± 0.2
	9/26	1.8	1.6	1.4	1.3	2.4	1.5 ± 0.2
Ammonia, mg/l	6/28	<0.01	<0.01	<0.01	<0.01	<0.01	
	7/22	<0.01	<0.01	0.03	0.01	0.01	<0.02 ± 0.01
	8/23	0.03	0.06	0.04	0.04	0.05	0.04 ± 0.01
	9/26	0.03	0.03	0.02	0.02	0.03	0.03 ± 0.01
Organic Nitrogen, mg/l	6/28	0.16	0.10	0.16	0.14	0.16	0.14 ± 0.03
	7/22	0.16	0.24	0.16	0.15	0.27	0.18 ± 0.04
	8/23	0.11	0.10	0.07	0.08	0.10	0.09 ± 0.02
	9/26	0.29	0.30	0.25	0.28	0.24	0.28 ± 0.02
Nitrate, mg/l	6/28	0.01	<0.01	<0.01	<0.01	<0.01	<0.01
	7/22	0.01	0.01	0.01	0.01	0.01	0.01
	8/23	0.01	<0.01	0.01	<0.01	0.01	<0.01
	9/26	0.03	0.04	0.04	0.04	0.04	0.04 ± 0.01
Nitrite, mg/l	6/28	0.01	<0.01	<0.01	<0.01	<0.01	<0.01
	7/22	0.01	<0.01	<0.01	<0.01	<0.01	<0.01
	8/23	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
	9/26	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Total Phosphate, mg/l	6/28	0.01	0.01	0.01	0.01	0.01	0.01
	7/22	0.08	0.04	0.06	0.07	0.09	0.06 ± 0.02
	8/23	0.02	0.02	0.01	0.02	0.05	0.01 ± 0.01
	9/26	0.02	0.02	0.02	0.02	0.02	0.02
Ortho Phosphate, mg/l	6/28	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
	7/22	0.01	<0.01	0.01	<0.01	0.01	<0.01
	8/23	0.01	0.01	0.01	0.01	0.04	0.01
	9/26	0.01	0.01	<0.01	0.01	0.01	<0.01
Temperature, °C	6/28	18	17	18	18	9	17.8 ± 0.5
	7/22	23	23	23	23	10	23 ± 0
	8/23	18	18	19	18	11	18.3 ± 0.5
	9/26	15	16	16	15	16	15.5 ± 0.6
Dissolved Oxygen, mg/l	6/28	9.2	8.9	8.7	9.1	9.2	9.0 ± 0.2
	7/22	7.5	8.0	8.1	7.9	7.9	7.9 ± 0.2
	8/23	8.9	8.9	8.9	8.9	9.1	8.9 ± 0
	9/26	8.6	8.6	8.4	8.6	7.8	8.4 ± 0.3
Conductivity, µmhos/cm	6/28	730	710	710	710	680	715 ± 10
	7/22	690	690	680	700	690	690 ± 8
	8/23	680	680	670	690	690	680 ± 8
	9/26	650	650	740	650	650	673 ± 45
pH, standard units	6/28	8.7	8.5	8.6	8.1	-	8.5 ± 0.3
	7/22	8.5	8.4	8.3	8.4	7.0	8.4 ± 0.1
	8/23	8.9	8.8	8.8	8.0	-	8.6 ± 0.4
	9/26	-	7.9	7.8	-	-	7.9 ± 0.1

Aluminum, mg/l	7/22	0.10	0.060	0.072	0.072	0.080	0.076 ± 0.017
Arsenic, mg/l	7/22	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Cadmium, mg/l	7/22	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Calcium, mg/l	7/22	55	59	51	98	52	66 ± 20
Chromium, mg/l	7/22	0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Copper, mg/l	7/22	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Iron, mg/l	7/22	0.043	0.029	0.033	0.033	0.083	0.035 ± 0.006
Lead, mg/l	7/22	0.02	0.02	0.02	0.024	0.02	0.021 ± 0.002
Manganese, mg/l	7/22	<0.005	<0.005	<0.005	<0.005	<0.006	<0.005
Magnesium, mg/l	7/22	20	20	20	22	66	21 ± 1
Potassium, mg/l	7/22	4.1	4.2	4.3	4.5	4.1	4.2 ± 0.2
Sodium, mg/l	7/22	56	60	60	65	69	60 ± 4
Zinc, mg/l	7/22	0.22	0.027	0.027	0.015	0.040	0.072 ± 0.089
Mercury, mg/l	7/22	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Barium mg/l	7/22	0.50	0.50	0.80	0.50	0.50	0.6 ± 0.13
Molybdenum mg/l	7/22	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Boron, mg/l	7/22	-	-	-	0.11	0.11	-
Fluoride, mg/l	7/22	-	-	-	0.46	0.42	-
Phenol, mg/l	7/22	-	-	-	1.8	0.8	-

Source: Woodward-Envicon, Inc., 1974.

1/ Sampling locations were established on Renner Bay during the Spring of 1974. L01 and L02 were located south and west of the proposed water intake, respectively. L03 was located in the mouth of Renner Bay, and L04 (surface) and L05 (bottom) were in the vicinity of the proposed intake.

LAKE SAKAKAWEA, · WATER QUALITY
HISTORICAL SUMMARY, OCTOBER 1972 THROUGH JULY 1974

Parameter	N	Mean	Deviation	Maximum	Minimum	Begin	End
Temperature, °C	18	6.8	4.2	13	2.5	10/72	6/74
Discharge, cfs - monthly	20	13780	6164	36500	16900	10/72	6/74
Color Pt-Co units	18	7	4	20	4	10/72	6/74
Conductivity, µmhos/cm	20	658	30	722	610	10/72	6/74
BOD, mg/l	2	1.0	0.3	1.2	1.8	7/74	7/74
pH	20	8.1	0.2	8.4	7.7	10/72	6/74
Carbon Dioxide, mg/l	21	2.6	1.7	5.6	1.0	10/72	6/74
Total Alkalinity (as $CaCO_3$, mg/l)	21	146	24	159	146	10/72	6/74
Bicarbonate, mg/l (HCO_3)	21	182	7	198	174	10/72	6/74
Carbonate (CO_3) mg/l	21	0.6	2	8	0	10/72	6/74
Total Nitrogen - N, mg/l	2	0.58	.32	.80	.35	4/74	6/74
Organic Nitrogen - N, mg/l	2	.42	.31	.64	.20	4/74	6/74
Ammonia Nitrogen - N, mg/l	2	.05	.035	.02	.07	4/74	6/74
Total Kjeldahl Nitrogen - N, mg/l	2	0.47	.35	.71	.22	4/74	6/74
Total Nitrate + Nitrate, mg/l	2	0.11	.03	.13	.09	4/74	6/74
Dissolved Nitrate + Nitrate, mg/l	18	.16	.07	.39	.08	10/72	6/74
Total Phosphorus as P, mg/l	2	.05	.05	.08	.01	4/74	6/74
Dissolved Phorphorus as P, mg/l	18	.02	.01	.03	0.0	4/74	6/74
Cyanide (CN), mg/l	3	0.0	0.0	0	0	4/74	6/74
Total Hardness (as $CaCO_3$, mg/l)	21	202	17	230	190	10/72	6/74
Dissolved Calcium, mg/l	21	49	4	55	36	10/72	6/74
Dissolved Magnesium, mg/l	20	20	1	22	16	10/72	6/74
Dissolved Sodium, mg/l	21	59	5	66	54	10/72	6/74
Sodium Absorp. Ratio	21	1.8	0.1	1.9	1.6	10/72	6/74
Percent Sodium	21	38	2	41	36	10/72	6/74
Dissolved Potassium, mg/l	21	4.3	0.9	4.5	3.8	10/72	6/74
Dissolved Chloride, mg/l	18	9.2	1.1	11.0	7.8	10/72	6/74
Dissolved Sulfate, mg/l	18	170	16	190	120	10/72	6/74
Dissolved Fluoride, mg/l	18	0.5	0.2	1.1	0.4	10/72	6/74
Total Fluoride, mg/l	1	0.8	-	-	-	4/74	4/71
Dissolved Silica, mg/l	18	7.3	0.4	7.9	6.2	10/72	6/74
Dissolved Arsenic, µg/l	18	2	2	5	0	10/72	6/74
Dissolved Barium, µg/l	4	0	0	0	0	4/73	4/74
Dissolved Beryllium, µg/l	4	0	0	0	0	4/73	4/74
Dissolved Boron, µg/l	18	118	25	170	40	10/72	6/74
Total Boron, µg/l	1	330	-	-	-	4/74	4/74
Dissolved Cadmium, µg/l	18	1	1	2	0	10/72	6/74
Dissolved Chromium, µg/l	4	2.5	5	10	0	4/73	6/74
Dissolved Cobalt, µg/l	4	1	1	2	0	4/73	6/74
Dissolved Copper, µg/l	4	5	3	7	2	4/73	6/74
Dissolved Iron, µg/l	4	20	12	30	9	4/73	6/74
Dissolved Lead, µg/l	4	2	2	4	0	4/73	6/74
Total Lead, µg/l	1	100	-	-	-	4/74	4/74
Dissolved Manganese, µg/l	4	23	30	67	0	4/73	6/74
Dissolved Molybdenum, µg/l	4	2	1	3	1	4/73	6/74
Dissolved Nickel, µg/l	4	3	3	6	0	4/73	6/74
Dissolved Silver, µg/l	4	0	-	-	-	4/73	6/74
Dissolved Strontium, µg/l	4	510	74	560	400	4/73	6/74
Dissolved Vanadium, µg/l	4	.2	0.1	.3	0	4/73	6/74
Dissolved Zinc, µg/l	4	33	33	80	10	4/73	6/74
Total Zinc, µg/l	1	430	-	-	-	4/74	-
Total Aluminum, µg/l	1	300	-	-	-	4/74	-
Dissolved Aluminum, µg/l	4	5	6	10	0	4/74	6/74
Dissolved Lithium, µg/l	4	50	11	60	40	4/74	6/74
Dissolved Selenium, µg/l	4	4	4	4	0	4/74	6/74
Suspended Solids, mg/l	2	2	0	2	-	4/74	6/74
Dissolved Solids, mg/l	20	432	23	448	400	10/72	6/74

Source: U.S. Environmental Protection Agency, STORET System, 1974.

KNIFE RIVER AT HAZEN, WATER QUALITY HISTORICAL SUMMARY, SEPTEMBER 1969 THROUGH MARCH 1974

Parameter	N	Mean	Deviation	Maximum	Minimum	Begin	End
Temperature, °C	39	8.61	8.30	25.00	0.00	10/69	9/73
Flow, cfs	43	464.7	1150.8	5930	13	9/69	9/73
Conductivity, µmhos	42	1403	485	2150	300	9/69	9/73
pH	28	7.89	.26	8.30	7.00	9/69	6/73
Total Alkalinity, mg/l as $CaCO_3$	28	402	136	621	89	9/69	6/73
NO_3-N, dissolved, mg/l	16	.33	.30	1.29	0.00	10/70	6/73
Ortho-PO_4, mg/l	8	.03	.05	.14	.00	6/71	6/73
Total Hardness, mg/l as $CaCO_3$	28	320	101	530	81	9/69	6/73
Ca, dissolved, mg/l	28	69.0	21.9	130	22	9/69	6/73
Mg, dissolved, mg/l	28	35.80	13.13	67.0	6.3	9/69	6/73
Na, dissolved, mg/l	28	228.5	79.6	330	32	9/69	6/73
% Sodium	28	59.18	5.60	72.00	43.00	9/69	6/73
K, dissolved, mg/l	28	6.93	1.23	8.90	1.60	9/69	6/73
Chloride, mg/l	28	3.75	2.71	9.10	.00	9/69	6/73
Sulfate, mg/l	28	404	131	640	68	9/69	6/73
Fluoride (f), dissolved, mg/l	28	.43	.25	.90	.00	9/69	6/73
Silica, dissolved, mg/l	28	11.23	3.6	18	4.8	9/69	6/73
Boron, dissolved, mg/l	28	.263	.303	1.300	0.00	9/69	6/73
Iron, dissolved, mg/l	16	.186	235	.740	.00	10/70	6/73
Manganese, dissolved, mg/l	16	.0219	16.0	.060	10	10/70	6/73
Dissolved solids, mg/l	28	1002	314	1550	219	9/69	6/73
NO_3, total, mg/l	8	1.18	0.73	2.8	.00	11/70	9/71
NO_3, dissolved, mg/l	28	1.22	1.11	5.7	.00	9/69	6/73
DO, mg/l	5	9.60	1.95	11.4	6.3	10/73	3/74
BOD, mg/l	2	2.95	.78	3.5	2.4	10/73	11/73
PO_4 - Total	5	0.08	0.09	.18	.01	10/73	3/74
Total Coliform #/100 ml	5	212	283	710	20	10/73	3/74
Fecal Coliform #/100 ml	5	26.00	16.7	50	10	10/73	3/74

Source: U. S. Environmental Protection Agency, STORET System, 1974.

SPRING CREEK AT ZAP, WATER QUALITY HISTORICAL SUMMARY, SEPTEMBER 1969 THROUGH MARCH 1974

Parameter	N	Mean	Deviation	Maximum	Minimum	Begin	End
Temperature, °C	28	7.46	7.91	24.00	0.0	10/69	9/73
Flow, cfs	31	107	277	1120	4.2	9/69	9/73
Conductivity, µmhos	31	1306	462	1870	180	9/69	9/73
pH	15	7.91	0.25	8.30	7.40	9/69	6/73
T-Alkalinity as $CaCO_3$, mg/l	15	374	101	509	157	9/69	6/73
NO_3-N, dissolved, mg/l	3	.23	-	-	-	6/72	-
Ortho PO_4, mg/l	3	.087	.085	.17	.00	6/72	6/73
Total Hardness as $CaCO_3$, mg/l	15	356	83	458	185	9/69	6/73
Ca, dissolved, mg/l	15	77	16.8	99	40	9/69	6/73
Mg, dissolved, mg/l	15	.40	12	56	21	9/69	6/73
Na, dissolved, mg/l	15	206	607	283	91	9/69	6/73
% Na	15	55	4	61	48	9/69	6/73
K, dissolved, mg/l	15	7.01	.55	7.90	6.00	9/69	6/73
Cl, mg/l	15	9.36	3.06	12.00	0.00	9/69	6/73
SO_4, mg/l	15	425	106	565	232	9/69	6/73
Fluoride, dissolved, mg/l	15	0.40	.21	.80	.10	9/69	6/73
Silica, dissolved, mg/l	15	10.88	3.86	18	6	9/69	6/73
Boron, dissolved, µg/l	15	.266	172	.560	0.00	9/69	6/73
Iron, dissolved, µg/l	3	.090	123	.230	0.00	6/72	6/73
Mn, dissolved, µg/l	3	.0433	30.55	.070	10	6/72	6/73
TDS, mg/l	15	983	246	1310	529	9/69	6/73
NO_3, dissolved, mg/l	15	.75	.75	2.5	.00	9/69	6/73
Fe, total, µg/l	12	847	1002	3000	0.00	9/69	8/70
DO, mg/l	5	10.16	1.11	11.3	8.4	10/73	3/74
BOD, mg/l	2	2.4	1.13	3.2	1.6	10/73	11/73
T-PO_4 - mg/l	5	0.064	.120	.28	.01	10/73	3/74
T-Coliform #/100 ml	5	254	313	800	30	10/73	3/74
F-Coliform #/100 ml	5	28	27	70	10	10/73	3/74

Source: U. S. Environmental Protection Agency, STORET System, 1974.

STREAM WATER QUALITY DATA, MERCER COUNTY, NORTH DAKOTA, 28 JUNE, 1974 THROUGH 26 SEPTEMBER, 1974

Parameter	Date	Location SO1	SO7	SO3	SO4	SO5
Total Hardness mg/l as ($CaCO_3$)	6/28	392	323	348	362	380
	7/22	327	285	299	283	344
	8/23	347	284	279	268	372
	9/26	370	326	328	-	-
Total Alkalinity, mg/l (as $CaCO_3$)	6/28	460	480	460	484	432
	7/22	478	528	486	454	480
	8/23	490	482	469	510	410
	9/26	510	598	524	-	-
Sulfate, mg/l	6/28	304	372	300	152	330
	7/22	284	318	251	177	287
	8/23	327	326	229	137	302
	9/26	524	444	339	-	-
Color Pt-Co, units	6/28	40	45	35	30	50
	7/22	50	50	50	55	60
	8/28	45	45	45	50	50
	9/26	40	40	40	-	-
Turbidity, FTU	6/28	37	24	21	5.5	5.6
	7/22	26	32	32	12	10
	8/23	23	26	23	17	16
	9/26	7.7	15	13	-	-
Biochemical Oxygen Demand, mg/l	6/28	3.9	3.2	3.7	3.7	3.8
	7/22	1.9	2.8	2.0	3.7	3.6
	8/23	2.7	3.5	5.6	7.3	3.2
	9/26	1.9	3.7	3.8	-	-
Chemical Oxygen Demand, mg/l	6/28	40	38	38	39	41
	7/22	40	36	37	47	47
	8/23	28	32	38	63	38
	9/26	28	33	32	-	-
Chloride, mg/l	6/28	5.5	4.5	5.5	6.5	7.0
	7/22	6.5	4.5	5.0	5.5	7.9
	8/23	7.1	4.0	5.9	6.8	7.9
	9/26	6.7	3.5	5.5	-	-
Total Solids, mg/l	6/28	1152	1290	1168	952	1116
	7/22	1150	1300	1148	882	1114
	8/23	1220	1326	986	872	1104
	9/26	1320	1298	1104	-	-
Total Dissolved Solids, mg/l	6/28	1098	1255	1127	828	1106
	7/22	1106	1242	1087	860	1089
	8/23	1134	1242	888	800	1072
	9/26	1308	1274	1080	-	-
Total Volatile Solids, mg/l	6/28	236	174	256	200	238
	7/22	222	236	246	176	226
	8/23	180	230	296	252	260
	9/26	270	166	176	-	-
Ammonia, mg/l	6/28	0.05	0.04	<0.01	<0.01	<0.01
	7/22	0.01	<0.01	<0.01	<0.01	0.02
	8/23	0.03	0.04	0.03	0.04	0.06
	9/26	0.03	0.02	0.05	-	-
Organic Nitrogen, mg/l	6/28	0.87	0.77	-	0.88	1.08
	7/22	0.98	1.01	0.78	1.60	1.44
	8/23	1.41	1.55	1.84	2.06	1.70
	9/26	0.63	1.02	0.84	-	-
Nitrate, mg/l	6/28	0.01	0.01	0.01	0.01	0.01
	7/22	0.01	0.02	0.01	0.01	0.01
	8/23	<0.01	<0.01	0.01	<0.01	<0.01
	9/26	0.02	0.02	0.01	-	-
Nitrite, mg/l	6/28	<0.01	<0.01	<0.01	<0.01	<0.01
	7/22	<0.01	<0.01	<0.01	<0.01	<0.01
	8/23	<0.01	<0.01	<0.01	<0.01	<0.01
	9/26	<0.01	<0.01	<0.01	-	-
Total Phosphate, mg/l	6/28	0.14	0.11	0.12	0.23	0.35
	7/22	0.30	0.29	0.28	0.41	0.63
	8/23	0.17	0.11	0.15	0.31	0.20
	9/26	0.05	0.09	0.09	-	-
Ortho Phosphate, mg/l	6/28	<0.01	<0.01	<0.01	0.07	0.17
	7/22	0.02	0.01	0.01	0.14	0.30
	8/23	0.03	0.02	0.02	0.07	0.11
	9/26	0.01	0.01	0.01	-	-
Temperature, ^{o}C	6/28	22	20	25	24	19
	7/22	24	23	24	24	20
	8/23	16	16	18	16	14
	9/26	15	15	17	-	-
Dissolved Oxygen, mg/l	6/28	7.5	6.9	7.0	5.4	5.6
	7/22	7.8	7.0	7.8	4.7	1.4
	8/23	7.8	7.3	10.0	6.3	6.3
	9/26	8.2	7.6	8.5	-	-
Conductivity	6/28	1700	1800	1600	1200	1600
	7/22	1600	1700	1500	1300	1600
	8/23	1900	2000	1450	1300	1650
	9/26	1800	1800	1500	-	-

(Continued)

Parameter	Date	Location SO1	SO2	SO3	SO4	SO5
pH, su.	6/28	8.4	8.5	8.3	8.2	8.6
	7/22	8.2	8.1	8.1	8.2	7.7
	8/23	8.9	8.8	8.9	9.1	8.4
	9/26	8.5	8.2	8.1	-	-
Aluminum, mg/l	7/22	0.68	0.72	0.56	0.10	0.10
Arsenic, mg/l	7/22	<0.01	<0.01	<0.01	<0.01	<0.01
Cadmium, mg/l	7/22	<0.005	<0.005	<0.005	<0.005	<0.005
Calcium, mg/l	7/22	79	105	64	69	50
Chromium, mg/l	7/22	0.008	<0.005	<0.005	<0.005	<0.005
Copper, mg/l	7/22	<0.01	<0.01	<0.01	<0.01	0.030
Iron, mg/l	7/22	2.8	1.1	1.3	0.28	0.73
Lead, mg/l	7/22	0.030	0.028	0.027	0.026	<0.02
Manganese, mg/l	7/22	0.25	0.21	2.2	0.65	0.22
Magnesium, mg/l	7/22	44	35	35	37	53
Potassium, mg/l	7/22	10	11	10	10	10
Sodium, mg/l	7/22	227	322	268	161	237
Zinc, mg/l	7/22	0.030	0.030	0.034	0.015	0.013
Mercury, mg/l	7/22	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Barium, mg/l	7/22	0.94	1.1	1.1	1.0	0.82
Molybdenum, mg/l	7/22	<0.01	<0.01	<0.010	<0.01	<0.01
Boron, mg/l	7/22	0.42	0.21	0.27	-	-
Fluoride, mg/l	7/22	0.46	0.38	0.38	-	-
Phenol, mg/l	7/22	2.2	2.0	2.4	-	-

Source: Woodward-Envicon, Inc. analyses, 1974.

CHEMICAL ANALYSES[1] OF SELECTED WATER SAMPLES

Parameter[2]	Upper Hell Creek-Lower Cannonball-Ludlow Aquifer		Fox Hills-Basal Hell Creek Aquifer			
	G03/940' Well/Depth	G93/730' Well/Depth	G75/1370' Well/Depth	G78/1205' Well/Depth	G79/1299' Well/Depth	Zap/1281' Well/Depth
Date	740620	740620	740621	740711	740621	740812
Temp (°C)	13.2	13.6	8.8	13.5	14.1	16.7
pH (units)	8.0	8.2	8.32	8.48	8.55	8.38
Color (units)				7		17
Turb (Jackson units)				J<25		J<25
Cond (umhos/cm)	2350	2450	2050	2230	2180	2300
TDS	1600	1690	1465	1470	1410	1464
Hardness	14	16	10	11	10	8
HCO_3	1285	1287	1179	1171	1025	1231
SO_4	1.5	1.2	1.6	10.9	4.8	<1.0
Na/SAR	545/74	565/74	530/85	500/54	498/80	590/86
Ca	2.5	2.5	2.0	5.0	2.0	2.8
Mg	0.92	1.1	0.58	0.84	0.59	0.48
K	2.5	2.5	2.2	2.0	2.0	2.0
Cl	236	274	212	185	228	250
Fe	0.23	0.45	0.61	0.36	0.18	4.5
Sn				13.6		0.065
F				4.2		5.2
B				1.8		2.1
Ba				0.94		<0.10
P	0.191	0.198	0.154	0.19	0.138	0.22
Cu				<0.01		0.010
Li				0.065		
Mn				0.01		0.087
Pb				0.05		<0.02
Mo				0.011		0.01
Ni				0.020		
As				<0.01		<0.01
CN				<0.01		
Cd				0.013		<0.005
Cr				0.010		<0.005
Se				<0.005		<0.005
Gross Alpha/Precision (pCi/l)				17/6		0.5/ 5.7
Gross Beta/Precision (pCi/l)				23/21		0/42

[1]Field analyses.

[2]All values in ppm unless otherwise indicated.

Source: Woodward-Envicon, Inc., 1974.

CHEMICAL ANALYSES[1] OF SELECTED WATER SAMPLES, LIGNITE AQUIFERS

Parameter[2]	G77/320' Well/Depth	G81/73.3' Well/Depth	G89/417' Well/Depth	G91/68.5' Well/Depth	NACCO1 3/	NACCO2 3/
Date	740701	740711	740712	740712	740719	740719
Temp (°C)	9.6	9.2	9.2			
pH (units)	8.48	7.05	7.48	7.15	8.26	6.52
Color (units)		14	4	85	30	40
Turb (Jackson units)	J<25	J<25	J<25	J<25	J<25	J500
Cond (umhos/cm)	2600	1600	1400	6500	2400	5200
TDS	2030	1270	987	4800	1972	5051
Hardness	51	472	35	809	551	1607
HCO_3	1257	783	786	1115	349	244
SO_4	412	394	182	2420	1136	3305
Na/SAR	688/46	266/5	342/30	1390/32	426/8	800/9
Ca	6.5	105	5.0	108	100	380
Mg	6.5	49	3.1	115	81	167
K	4.4	11	3.5	13	12	19
Cl	105	3.4	3.0	54	16	16
Fe	8.4	4.1	0.08	1.2	0.37	8.6
Sn		0.32	0.057	0.23	0.012	0.20
F		0.72	0.087	0.66	0.70	<0.1
B		0.51	0.61	0.83	0.63	1.1
Ba		0.46	0.46	0.40	0.61	<0.1
P	0.297	<0.1	<0.1	<0.1	<0.01	<0.01
Cu		0.088	0.017	0.013	<0.01	0.049
Li			0.054		0.044	0.20
Mn		0.44	0.27	0.039	0.037	0.32
Pb		0.061	<0.02	0.053	0.02	0.032
Ni		0.01	<0.01	0.01	<0.01	0.014
Si			<0.01		0.023	0.078
As		<0.01	<0.01	<0.01	<0.01	<0.01
CN		<0.01	0.033	<0.01		
Cd		0.005	<0.005	0.009	0.006	0.009
Cr		0.010	<0.005	0.006	<0.005	<0.005
Se		<0.005	<0.005	0.082	<0.005	<0.005
Gross Alpha/Precision (pCi/l)		6.1/ 4.4	8.0/ 4.1	40/16	67/12	290/45
Gross Beta/Precision (pCi/l)		6.8/ 14.3	0/13	275/69	68/27	280/120
				275/69	68/27	280/120

[1]Field analyses.

[2]All values in ppm unless otherwise indicated.

Source: Woodward-Envicon, Inc., 1974.

3/ Taken from mine pits at Indian Head Mine.

CHEMICAL ANALYSES[1] OF SELECTED WATER SAMPLES, LIGNITE AQUIFERS

Parameter	G02/36' Well/Depth	G04/120' Well/Depth	G09/100' Well/Depth	G12/25' Well/Depth	G15/113' Well/Depth	G16/140' Well/Depth	G23/120' Well/Depth	G25/110' Well/Depth	G57/335' Well/Depth
Date	740711	740718	740706	740710	740629	740629	740629	740706	740622
Temp[2] (°C)	6.9	12.1	10.9	6.7	9.9	9.2	9.0	11.2	6.3
pH[2] (units)	7.72	8.45	7.28	7.05	7.79	6.98	7.88	8.77	7.37
Color (units)	11	-	12	40	-	11	12	10	-
Turb (Jackson unit)	J<25	-	J350	J<25	-	J320	J115	J240	-
Cond[2] (µmhos/cm)	2850	1225	1275	3800	1000	1190	1000	650	285
TDS	2200	-	1530	5570	-	934	741	482	-
Hardness	231	-	660	1803	-	529	369	143	-
HCO_3[2]	827	594	652	1093	637	590	564	242	110
SO_4	1000	-	599	3010	-	256	142	123	-
Na/SAR	590/16	285	250/5	867/9	-	115/2	126/3	99/3	-
Ca	49	-	85	400	-	87	73	24	-
Mg	34	-	71	158	-	53	36	20	-
K	8.6	-	9.2	19	-	9.2	7.3	7.4	-
Cl	4.0	<36	8.8	15	<36	15	5.6	5.6	<36
Fe	0.48	-	8.9	0.88	-	10.1	7.4	10.5	-
Zn	0.27	-	13.5	2.5	-	2.2	0.48	0.42	-
F	0.16	-	0.63	0.72	-	1.4	1.4	1.0	-
B	0.92	-	0.79	1.0	-	0.71	0.55	0.45	-
Ba	0.40	-	1.3	0.7	-	1.7	1.2	1.0	-
P	<0.1	-	<0.1	<0.1	-	<0.1	0.12	0.36	-
Cu	0.027	-	0.49	0.15	-	0.63	0.75	0.39	-
Li	0.091	-	-	0.082	-	-	-	-	-
Mn	0.056	-	1.6	0.060	-	0.36	0.23	0.16	-
Pb	0.039	-	0.39	0.055	-	0.12	0.12	0.2	-
Mo	<0.1	-	<0.01	0.02	-	0.02	0.025	<0.01	-
Ni	0.018	-	-	0.041	-	-	-	-	-
As	<0.01	-	<0.01	<0.01	-	<0.01	<0.01	<0.01	-
CN	<0.01	-	0.021	<0.01	-	0.018	<0.01	0.041	-
Cd	0.007	-	0.005	0.008	-	0.025	0.017	<0.005	-
Cr	0.007	-	0.019	0.007	-	0.015	0.011	0.019	-
Se	<0.005	-	<0.005	0.005	-	<0.005	<0.005	<0.005	-
Gross Alpha/Precision (pCi/l)	52/9	-	42/8	170/20	-	22/6	4/7	23/4	-
Gross Beta/Precision (pCi/l)	64/22	-	18/15	145/40	-	13/14	24/13	14/2	-

[1]Field analyses.

[2]All values in mg/l unless otherwise indicated.

Source: Woodward-Envicon, Inc., 1974.

CHEMICAL ANALYSES[1] OF SELECTED WATER SAMPLES, OUTWASH AQUIFER

Parameter	G01/229 Well/Depth	G05/224 Well/Depth	G06/156 Well/Depth	G10/155 Well/Depth	G17/200 Well/Depth	G28/230 Well/Depth	G60/225 Well/Depth	G92/41 Well/Depth	Beulah/46	Hazen Composite
Date	740718	740727	740710	740727	740710	740727	740618	740620	740812	704812
Temp[2] (°C)	-	8.4	9.4	8.9	7.7	8.8	8.8	9.1	8.8	9.2
pH[2] (units)	7.99	7.82	7.66	7.42	7.75	7.99	7.35	7.18	7.5	7.45
Color (units)	7	-	15	5	5	35	15	-	29	65
Turb (Jackson)	J<25	-	J240	J35	J800	J<25	140	-	J<25	J<25
Cond[2] (µmhos/cm)	1080	310	770	1850	750	590	700	460	850	1100
TDS	673	-	808	1410	1471	375	576	-	590	746
Hardness[2]	209	-	302	568	368	216	302	-	283	335
HCO_3	793	178	691	1030	527	427	305	377	539	661
SO_4	6.4	-	136	426	79.2	5.6	94	-	95.6	149
Na/SAR	180/5	19.8/	150/4	289/5	43/0.8	59/2	-	-	85/2	150/4
Ca	31	-	74	153	148	51	-	-	72	76
Mg	33	-	33	56	48	20	-	-	37	29
K	9.7	-	11.2	9.9	6.7	5.1	-	-	4.8	5.8
Cl	5.6	-	9.6	2.4	6.4	6.8	11	<36	5.6	13
Fe	0.63	-	15	9.3	51	1.5	-	-	0.66	7.1
Zn	1.2	-	1.6	0.097	18.5	0.055	-	-	0.24	0.045
F	1.0	-	0.80	0.87	0.84	0.76	-	-	0.30	0.45
B	0.53	-	0.41	0.77	0.40	0.66	-	-	0.19	0.1
Ba	0.46	-	1.6	0.50	2.9	<0.1	-	-	<0.1	<0.1
P	<0.01	-	0.01	<0.1	<0.01	0.09	2.23	-	0.33	0.02
Cu	<0.01	-	0.082	<0.012	0.046	<0.01	-	-	0.033	0.037
Li	-	-	-	0.061	-	-	-	-	-	-
Mn	0.059	-	0.79	0.69	2.5	0.082	-	-	0.055	0.12
Pb	0.02	-	0.045	0.035	0.047	0.031	-	-	<0.02	0.022
Mo	<0.01	-	<0.01	<0.1	0.011	<0.01	-	-	0.01	0.01
Ni	-	-	-	0.02	-	-	-	-	-	-
As	<0.01	-	0.011	0.01	0.026	<0.01	-	-	<0.01	<0.01
CN	0.18	-	<0.01	<0.01	0.037	0.046	-	-	-	-
Cd	<0.005	-	0.005	<0.005	0.006	<0.005	-	-	<0.005	0.006
Cr	<0.005	-	0.02	<0.005	0.030	<0.005	-	-	<0.005	<0.005
Se	<0.005	-	<0.005	<0.005	<0.005	<0.005	-	-	<0.005	<0.005
Gross Alpha/Precision (pCi/l)	0/1.6	-	1/2.2	26/6	1.9/2.6	0.5/1.5	-	-	0/2.6	0.7/ 2.6
Gross Beta/Precision (pCi/l)	4/13	-	18/13	29/15	0/13	0/11	-	-	0/20	0/20

[1]Field analyses.

[2]All values in mg/l unless otherwise indicated.

Source: Woodward-Envicon, Inc., 1974.

CHEMICAL ANALYSES[1] OF SELECTED MISCELLANEOUS WATER SAMPLES

Parameter[2]	G19/23.6 OW[3] Well/Depth Aquifer	G29/15.8 AL/OW[4] Well/Depth Aquifer	G30 OW Well/Depth Aquifer	G61/40 SB[5] Well/Depth Aquifer	G06/28 OW Well/Depth Aquifer	G98 SB Well/Depth Aquifer	G13 23.8 AL Well/Depth Aquifer	G34 62.5 AL Well/Depth Aquifer	G58 18.3 AL Well/Depth Aquifer
Date	740622	740620	740620	740622	740621	740710	740629	740727	740621
Temp (°C)	6.9	11.7	10.6	6.7	8.3	7.7	8.9		8.7
pH	7.03	7.46	7.55	7.01	7.27	7.4	7.48	7.77	7.56
Color (units)						7	4		
Turb (Jackson units)						J<25	J800		
Cond (µmhos/cm)	1800	3650	1150	1130	1650	1900	590	820	600
TDS		3178	902			3280	491	496	
Hardness		1686	237			172	350	288	
HCO_3	712	618	755	553	377	586	412	605	471
SO_4		894	156			630	81.2	39.2	
Na/SAR		239/3	241/7			393/13	26/0.6	79/2	
Ca		205	48			43	90	102	
Mg		249	22			18	32	49	
K		6.1	5.1			6.6	21	8.7	
Cl	<36	192	6.0	29	<36	8.8	2.0	16	<36
Fe		0.13	3.1			3.4	29.8	59	
Sn						0.44	2.0		
F						0.11	13.5		
B						0.53	11.5		
Ba						0.20	3.2		
P		0.054	0.011			<0.1	0.23	0.582	
Cu						0.011	2.5		
Li									
Mn						0.28	0.66		
Pb						0.029	0.23		
Mo						<0.01	0.016		
Ni									
As						<0.01	<0.01		
CN						<0.01	<0.01		
Cd						0.005	0.84		
Cr						<0.005	0.045		
Se						<0.005	<0.005		
Gross Alpha/Precision (pCi/l)						7.4/			
Gross Beta/Precision (pCi/l)						3.9 17/15	33/7 46/13		

[1] Field analyses.

[2] All values in ppm unless otherwise indicated.

[3] Outwash.

[4] Alluvium or outwash.

[5] Sentinel Butte.

Source: Woodward-Envicon, Inc., 1974.

CHEMICAL ANALYSES[1] OF SELECTED WATER SAMPLES FROM SPRINGS

Parameter[2]	F01 Spring	F02 Spring	F03 Spring	F04 Spring	F05 Spring
Date	740621	740622	740702	740622	740710
Temp (°C)	8.9	8.0	8.8	8.3	9.0
pH (units)	7.35	7.05	6.67	6.05	7.77
Color (units)	11	47	45		
Turb (Jackson units)	J<25	J<25	J<25		
Cond (µmhos/cm)	2250	2150	1250	950	1180
TDS	1600	1930	808	987	880
Hardness	111	350	363	634	468
HCO_3	777	821	434	179	508
SO_4	964	795	329	494	315
Na/SAR	473/19	505/12	158/4	27/0.5	107/2
Ca	18	58	73	105	113
Mg	17	45	35	63	49
K	6.7	8.9	6.5	4.6	8.6
Cl	2.6	4.8	0.8	5.6	0.4
Fe	0.14	0.17	5.0	11	0.43
Sn	0.010	0.22	0.10		
F	0.9	0.7	0.33		
B	0.87	0.76	0.48		
Ba	0.46	0.46	0.62		
P	<0.1	<0.1	<0.1	0.047	0.029
Cu	0.01	<0.01	0.015		
Li					0.062
Mn	0.033	0.014	0.11		
Pb	0.046	0.059	0.038		
Mo	<0.01	<0.01	<0.01		
Ni					0.011
As	<0.01	<0.01	<0.01		
CN	<0.01	<0.01	<0.01		
Cd	<0.005	0.006	<0.005		
Cr	<0.005	<0.005	<0.005		
Se	<0.005	<0.005	<0.005		
Gross Alpha/Precision (pCi/l)	49/7	94/9	62/8		
Gross Beta/Precision (pCi/l)	50/21	103/16	102/14		

[1] Field analyses.

[2] All values in ppm unless otherwise indicated.

Source: Woodward-Envicon, Inc., 1974.

Appendix F

Drill Hole Core Data

SUMMARY OF INTERVAL SAMPLE STRATA - DRILL HOLES TH-1, TH-2, TH-3, TH-4, TH-5, TH-6, TH-7A AND TH-8

Sample No.	Depth, ft From	To	Description
	Drill Hole TH-1		
1	1.0	9.0	Silts, sands, and clays, some concretion fragments.
2	9.0	33.0	Sands and clays, interbedded and intergraded.
3	33.0	48.0	Sands, clays, and silts, interbedded and intergraded.
4	48.0	53.0	Claystone with a hard lignite layer.
5	53.0	69.0	Claystone with some coal stringers and thin sandstone layers.
6	69.0	74.0	Claystone with lignite layers and carbonaceous stringers.
7	74.0	82.0	Sandstone and claystone, interbedded and intergraded, hard 1-ft limestone layer removed.
8	82.0	97.3	Claystone and sandstone, interbedded and intergraded.
9	97.3	98.8	Sandstone, well cemented, hard, very fine grained.
10	98.8	103.0	Sandstones, some clay, some lignite stringers.
11	103.0	108.5	Sandstone and claystone, lignite layer at top and coal layer at bottom of interval.
12	108.5	126.5	Sandstones, silty and argillaceous, some very hard and cemented.
13	126.5	137.0	Sandstone and claystone, interbedded and intergraded.
14	137.0	149.3	Claystone with thin lenticular sandstone layers.
	Drill Hole TH-2		
15	1.5	8.0	Clay, some pebbles and concretion fragments.
16	8.0	15.0	Clay.
17	15.0	23.0	Claystone.
18	23.0	31.5	Claystone, grey, with silt, sand, and lignite.
19	31.5	48.0	Sandstone and claystone.
20	48.0	62.0	Claystone and sandstone, interbedded and intergraded, some thin hard limestone layers.
21	62.0	71.5	Claystone, some sands and layers of lignite.
	Drill Hole TH-3		
22	5.0	28.0	Clay, with some aggregates, pebbles, sand, and silt.
23	28.0	63.0	Clay, some silt and sand.
	Drill Hole TH-4		
24	8.0	33.0	Clay, silty, sandy, and with gravel and crystallized aggregates.
	Drill Hole TH-5		
25	4.0	20.0	Sands and clay, some silt and gravel.
	Drill Hole TH-6		
26	3.5	10.0	Clay, silty, sandy, with some gravel.
27	10.0	19.0	Claystone.
28	19.0	22.0	Sands and silt, very fine grained, uniform texture, loose.
	Drill Hole TH-7A		
29	1.0	40.0	Clay and silt, some sand and gravel.
	Drill Hole TH-8		
30	4.0	15.0	Clay, silty, with some gravel.

Source: Colorado School of Mines Research Institute, 1974.

CHEMICAL ANALYSIS DATA - DRILL HOLES TH-1, TH-2, TH-3, TH-4, TH-5, TH-6, TH-7A, AND TH-8

Sample No.	Depth, ft From	Depth, ft To	pH Water (1)	pH 0.01M $CaCl_2$ Solution (2)	Soluble Salts Extract Conductivity millimhos/cm (1)	Soluble Salts Extract Conductivity millimhos/cm (3)	Sodium Water Soluble[1]	Sodium NH_4 Acetate Soluble	Cation Exchange Capacity	Exchangeable Sodium Percentage (4)
							milliequivalents/100 g			
	Drill Hole TH-1									
1	1.0	9.0	7.7	7.6	0.23	1.1	0.15	0.54	26.8	1.5
2	9.0	33.0	7.7	7.4	0.96	5.9	0.20	0.62	19.1	2.2
3	33.0	48.0	7.9	7.2	0.23	1.4	0.20	0.52	17.4	1.8
4	48.0	53.0	6.7	6.7	0.48	1.8	0.31	0.80	49.5	1.0
5	53.0	69.0	8.2	7.4	0.45	1.2	0.76	2.30	30.4	5.1
6	69.0	74.0	7.7	7.0	1.00	2.0	1.95	5.90	42.3	9.3
7	74.0	82.0	8.8	7.8	0.78	1.6	1.61	6.55	26.5	18.6
8	82.0	97.3	9.0	8.4	0.80	1.2	1.78	9.98	31.0	26.5
9	97.3	98.8	9.4	8.2	0.55	2.1	1.13	5.29	13.7	30.4
10	98.8	103.0	9.3	8.5	0.95	1.6	1.95	10.2	29.9	27.6
11	103.0	108.5	7.4	6.8	0.95	2.0	2.07	11.5	66.2	14.2
12	108.5	126.5	9.1	8.4	0.95	1.5	2.00	10.6	30.8	27.9
13	126.5	137.0	8.8	8.5	0.95	1.2	1.93	2.99	32.6	3.3
14	137.0	149.3	9.0	8.6	0.90	1.2	1.86	12.8	23.4	46.8
	Drill Hole TH-2									
15	1.5	8.0	8.3	7.6	2.30	6.4	2.56	3.86	39.7	3.3
16	8.0	15.0	8.4	7.8	1.28	2.4	2.34	6.25	39.0	10.0
17	15.0	23.0	8.5	7.7	0.55	1.1	1.04	3.45	36.5	6.6
18	23.0	31.5	6.8	6.4	1.45	2.9	2.73	5.47	69.0	4.0
19	31.5	48.0	8.8	7.7	0.75	1.2	1.43	7.81	23.9	26.7
20	48.0	62.0	9.1	8.4	0.93	1.1	1.91	13.9	32.1	37.4
21	62.0	71.5	8.4	7.6	1.20	1.6	2.65	3.47	47.7	1.7
	Drill Hole TH-3									
22	5.0	28.0	7.8	7.6	3.00	9.7	0.89	1.00	27.8	0.4
23	28.0	63.0	7.7	7.5	1.10	3.5	0.51	1.00	31.5	1.6
	Drill Hole TH-4									
24	8.0	33.0	7.8	7.7	4.10	12.5	3.34	3.65	30.8	1.0
	Drill Hole TH-5									
25	4.0	20.0	7.8	7.4	3.77	13.9	1.02	1.22	22.4	0.9
	Drill Hole TH-6									
26	3.5	10.0	7.9	7.8	2.30	6.6	1.02	1.39	34.3	1.1
27	10.0	19.0	7.5	7.4	3.80	9.9	0.89	1.22	31.0	1.1
28	19.0	22.0	5.6	5.2	1.45	6.3	0.32	0.42	8.68	1.2
	Drill Hole TH-7A									
29	1.0	40.0	7.7	7.3	1.45	4.8	0.49	0.95	27.1	1.7
	Drill Hole TH-8									
30	4.0	15.0	8.1	7.8	2.15	5.7	3.30	3.82	32.6	1.6

(Continues)

Sample No.	Depth, ft From	Depth, ft To	Potassium Available ppm	Phosphorus $NaHCO_3$ Soluble ppm	Nitrate ppm	Ammonium ppm	Organic Matter %	DTPA Extractable Cu ppm	DTPA Extractable Fe ppm	DTPA Extractable Mn ppm	DTPA Extractable Zn ppm	Boron Water Soluble ppm
	Drill Hole TH-1											
1	1.0	9.0	360	0.6	4.0	2	5.1	7.2	108	36.6	3.8	1.1
2	9.0	33.0	265	33.0	3.3	1	4.7	5.1	94	44.8	2.6	<1.0
3	33.0	48.0	275	22.0	2.3	5	2.6	1.8	104	37.2	2.4	<1.0
4	48.0	53.0	395	3.3	3.3	12	>8.0	4.0	140	36.0	6.6	3.2
5	53.0	69.0	525	8.8	1.5	18	4.1	6.6	148	16.0	5.6	<1.0
6	69.0	74.0	640	4.4	5.3	17	>8.0	7.8	126	11.2	7.2	3.4
7	74.0	82.0	605	1.0	4.5	18	3.6	6.0	188	23.6	5.2	1.3
8	82.0	97.3	680	1.0	2.5	17	4.3	8.6	138	12.8	6.6	1.9
9	97.3	98.8	310	12.0	2.0	15	2.1	3.8	152	28.0	2.4	<1.0
10	98.8	103.0	595	4.0	2.8	21	3.0	7.2	118	8.0	5.4	<1.0
11	103.0	108.5	425	0.6	1.0	15	>8.0	4.4	152	28.8	4.8	5.0
12	108.5	126.5	540	6.0	3.8	15	2.6	4.2	126	12.0	4.4	7.8
13	126.5	137.0	180	1.8	1.8	22	3.3	8.4	146	14.0	7.6	3.6
14	137.0	149.3	740	0.6	1.3	31	3.8	4.8	162	10.0	7.6	3.8
	Drill Hole TH-2											
15	1.5	8.0	300	14.4	<1.0	9	1.0	5.4	206	76.4	2.4	<1.0
16	8.0	15.0	575	3.0	1.8	8	2.4	4.2	138	26.4	0.8	<1.0
17	15.0	23.0	285	1.0	2.0	8	2.0	6.2	116	40.8	1.2	<1.0
18	23.0	31.5	520	1.0	2.3	21	>8.0	7.2	344	54.8	5.2	3.6
19	31.5	48.0	565	0.6	1.5	13	2.1	4.6	156	11.6	3.0	1.3
20	48.0	62.0	720	6.0	5.5	24	2.5	14.8	228	18.0	6.2	1.9
21	62.0	71.5	185	7.6	5.0	23	>8.0	10.8	174	16.0	7.0	6.2
	Drill Hole TH-3											
22	5.0	28.0	440	1.0	2.0	11	1.5	5.2	178	98.0	1.6	<1.0
23	28.0	63.0	700	7.2	3.8	25	2.8	7.6	260	45.6	3.6	<1.0
	Drill Hole TH-4											
24	8.0	33.0	395	10.0	5.0	12	1.8	5.0	150	48.4	1.0	<1.0
	Drill Hole TH-5											
25	4.0	20.0	420	4.4	1.3	6	1.0	2.6	162	55.6	1.0	<1.0
	Drill Hole TH-6											
26	3.5	10.0	300	3.0	<1.0	9	0.8	3.6	136	43.6	0.6	<1.0
27	10.0	19.0	470	0.6	25.0	9	1.4	7.6	94	24.4	0.6	<1.0
28	19.0	22.0	155	3.6	7.8	21	0.6	2.2	244	3.2	3.0	<1.0
	Drill Hole TH-7A											
29	1.0	40.0	405	11.8	23.8	6	0.5	3.4	178	83.6	0.8	<1.0
	Drill Hole TH-8											
30	4.0	15.0	460	6.0	17.0	4	0.5	4.2	162	55.2	1.0	<1.0

(Continues)

Sample No.	Depth, ft From	Depth, ft To	Selenium Available ppm	Arsenic Total ppm	Cadmium Total ppm	Fluoride Total ppm	Lead Total ppm	Mercury Total ppm	Molybdenum Total ppm	Nickel Total ppm	Radioactivity (5)
	Drill Hole TH-1										
1	1.0	9.0	0.04	<2	0.20	220	12	0.035	<1	26	0.33
2	9.0	33.0	0.03	<2	0.15	160	8	0.040	<1	27	0.58
3	33.0	48.0	0.02	2	0.15	150	8	0.050	1	27	0.53
4	48.0	53.0	0.02	5	0.25	240	12	0.075	8	50	0.42
5	53.0	69.0	0.03	2	0.30	350	14	0.075	1	37	0.13
6	69.0	74.0	0.02	2	0.40	330	21	0.140	1	37	0.17
7	74.0	82.0	0.03	<2	0.40	260	8	0.070	<1	34	0.52
8	82.0	97.3	0.02	2	0.45	310	16	0.100	<1	42	0.50
9	97.3	98.8	0.02	<2	0.10	130	7	0.045	<1	16	0.41
10	98.8	103.0	0.03	<2	0.35	250	11	0.080	<1	30	0.28
11	103.0	108.5	0.04	10	0.35	180	7	0.130	2	15	0.40
12	108.5	126.5	0.03	<2	0.30	100	8	0.065	<1	25	0.80
13	126.5	137.0	0.02	<2	0.50	410	16	0.100	<1	42	0.62
14	137.0	149.3	0.03	<2	0.40	310	14	0.100	<1	35	0.57
	Drill Hole TH-2										
15	1.5	8.0	0.04	2	0.20	260	13	0.040	1	27	0.46
16	8.0	15.0	0.03	<2	0.40	230	14	0.080	<1	34	0.44
17	15.0	23.0	0.01	<2	0.45	290	17	0.085	<1	35	0.39
18	23.0	31.5	0.02	10	0.35	180	9	0.120	2	30	0.45
19	31.5	48.0	0.04	2	0.25	170	9	0.045	<1	29	0.75
20	48.0	62.0	0.03	<2	0.45	150	15	0.065	<1	35	0.62
21	62.0	71.5	0.03	5	0.50	370	17	0.120	2	35	0.62
	Drill Hole TH-3										
22	5.0	28.0	0.03	2	0.25	250	11	0.050	2	24	0.46
23	28.0	63.0	0.03	2	0.30	320	12	0.060	1	26	0.73
	Drill Hole TH-4										
24	8.0	33.0	0.02	2	0.35	210	13	0.050	<1	29	0.61
	Drill Hole TH-5										
25	4.0	20.0	0.02	<2	0.25	170	10	0.050	<1	26	0.52
	Drill Hole TH-6										
26	3.5	10.0	0.03	<2	0.30	150	11	0.060	<1	26	0.61
27	10.0	19.0	0.03	<2	0.45	280	14	0.070	<1	35	0.70
28	19.0	22.0	0.04	2	0.05	80	3	0.090	1	4	0.52
	Drill Hole TH-7A										
29	1.0	40.0	0.03	<2	0.25	210	11	0.050	1	26	0.53
	Drill Hole TH-8										
30	4.0	15.0	0.03	<2	0.35	290	14	0.065	1	30	0.17

1/ Sample to extract ratio: 1 to 2
2/ Sample to extract ratio: 1 to 5
3/ Estimated conductivity for a saturation extract: basis, 1 to 2 ratio conductivity and 1/3 bar water-holding capacity data
4/ Calculated from the equation: exchangeable sodium percentage = $\frac{(100)(\text{Na, ammonium acetate soluble} - \text{Na, water soluble})}{(\text{cation exchange capacity})}$
5/ Ratio of sample activity to activity of a quartz monzonite standard (Lucius-Pitkin Company) containing 6 ppm U, 22 ppm Th, and 3.2% K.

Source: Colorado School of Mines Research Institute, 1974.

Appendix G

Plant Species
Botanical Compositions of Habitat Types
Aquatic Sampling Data

PLANT SPECIES PRESENT IN THE AREA OF THE PROPOSED COAL GASIFICATION FACILITY SITE IN MERCER COUNTY, NORTH DAKOTA

Common Name	Scientific Name[1]	Longevity[2]	Origin[3]	Life Form[4]	Response to Grazing[5]	Comments
Absinth	Artemisia absinthium	P	I	F	I	Half-shrub
Alfalfa	Medicago sativa	P	I	F	-	Cultivated legume
Alumroot	Heuchera richardsonii	P	N	F	-	--
Anemone, Canada	Anemone canadensis	P	N	F	-	--
Arrowgrass	Triglochin maritima	P	N	F	-	--
Arrowhead	Sagittaria cuneata	P	N	F	-	Emergent aquatic
Artichoke, Jerusalem	Helianthus tuberosus	P	N	F	-	--
Ash, green	Fraxinus pennsylvanica	-	N	W	-	Tree
Aspen, quaking	Populus tremuloides	-	N	W	-	Tree
Aster, aromatic	Aster oblongifolius	P	N	F	-	
Aster, golden	Chrysopsis villosa	P	N	F	I	--
Aster, rush	Aster junciformis	P	N	F	-	--
Aster, tall white	Aster coerulescens	P	N	F	-	--
Aster, white prairie	Aster ericoides	P	N	F	-	--
Aster, white upland	Aster ptarmicoides	P	N	F	-	--
Barley	Hordeum vulgare	A	-	G	-	Crop species
Barley, wild	Hordeum jubatum	P	N	G	IV	Mid-grass
Bearberry	Arctostaphylos uva-ursi	-	N	W	-	Trailing shrub
Beardtongue, slender	Penstemon gracilis	P	N	F	D	--
Beardtongue, white	Penstemon albidus	P	N	F	D	--
Bedstraw, northern	Galium boreale	P	N	F	-	--
Bergamont, wild	Monarda fistulosa	P	N	F	D	--
Bindweed, field	Convolvulus arvensis	P	I	F	-	--
Bluebell	Campanula rotundifolia	P	N	F	-	--
Bluegrass, fowl	Poa palustris	P	N	G	IV	Mid-grass
Bluegrass, Kentucky	Poa pratensis	P	I	G	IV	Mid-grass
Bluegrass, plains	Poa arida	P	N	G	D	Mid-grass
Bluegrass, swollen	Poa glaucifolia	P	N	G	D	Mid-grass
Bluegrass, Sandberg	Poa secunda	P	N	G	I	Short-grass
Bluestem, big	Andropogon gerardi	P	N	G	D	Tall-grass
Bluestem, little	Andropogon scoparius	P	N	G	D	Mid-grass
Boneset, false	Kuhnia eupatorioides	P	N	F	-	--
Box-elder	Acer negundo	-	N	W	-	Tree
Breadroot, indian	Psoralea esculenta	P	N	F	D	Legume
Brome, smooth	Bromis inermis	P	I	G	IV	Hay grass
Broomweed	Gutierrezia sarothrae	P	N	F	I	Half-shrub
Buckwheat, wild	Polygonum convolvulus	A	N	F	IV	--
Buffaloberry	Shepherdia argentea	-	N	W	-	High shrub
Buffalograss	Buchloe dactyloides	P	N	G	I	Short-grass
Bulrush, hardstem	Scirpus acutus	P	N	S	D	Emergent aquatic
Bulrush, prairie	Scirpus paludosus	P	N	S	D	--
Bulrush, river	Scirpus fluviatilis	P	N	S	D	Emergent aquatic
Bulrush, softstem	Scirpus validus	P	N	S	D	Emergent aquatic
Burningbush	Kochia scoparia	A	N	F	IV	--
Burreed	Sparganium eurycarpum	P	N	-	-	Emergent aquatic
Buttercup, marsh	Ranunculus septentrionalis	P	N	F	-	--
Cacti	Mamillaria sp. and Opuntia sp.	P	N	-	I	--
Candelabra, fairy	Androsace occidentalis	A	N	F	-	--
Caragana	Caragana arborescens	-	I	W	-	High shrub
Carrion-flower	Smilax herbacea	P	N	F	-	--
Catafoot	Antennaria sp.	P	N	F	I	--
Cattail, broad-leaved	Typha latifolia	P	N	-	-	Emergent aquatic
Cattail, narrow-leaved	Typha angustifolia	P	N	-	-	Emergent aquatic
Cedar, creeping	Juniperus horizontalis	-	N	W	-	Trailing shrub
Cherry, choke	Prunus virginiana	-	N	W	-	High shrub
Cherry, ground	Physalis lanceolata	P	N	F	-	--
Cherry, Nanking	Prunus tomentosa	-	I	W	-	Tree
Cherry, sand	Prunus pumila	-	N	W	-	Low shrub
Chickweed, prairie	Cerastium arvense	P	N	F	-	--
Cinquefoil, Pennsylvania	Potentilla pennsylvanica	P	N	F	-	--
Cinquefoil, rough	Potentilla norvegica	B	N	F	IV	--
Cinquefoil, silverweed	Potentilla anserina	P	N	F	I	--
Cinquefoil, tall	Potentilla arguta	P	N	F	-	--
Clover, owl	Orthocarpus luteus	A	N	F	-	--
Clover, purple prairie	Petalostemum purpureum	P	N	F	D	Legume
Clover, sweet	Melilotus sp.	B	I	F	-	Cultivated legume
Collomia	Collomia linearis	A	N	F	IV	--
Coneflower, long-headed	Ratibida columnifera	P	N	F	IV	--
Coneflower, purple	Brauneria angustifolia	P	N	F	D	--
Cordgrass, alkali	Spartina gracillis	P	N	G	D	Mid-grass
Cordgrass, prairie	Spartina pectinata	P	N	G	D	Tall-grass
Corn	Zea mays	A	-	G	-	Crop species
Cottonwood	Populus deltoides	-	N	W	-	Tree
Crab, Siberian	Malus baccata	-	I	W	-	Tree
Creeper, Virginia	Parthenocissus inserta	-	N	W	-	Vine
Currant, golden	Ribes odoratum	-	N	W	-	Low shrub
Currant, wild black	Ribes americanum	-	N	W	-	Low shrub
Dock, curled	Rumex crispus	P	I	F	-	--
Dock, golden	Rumex persicarioides	B	N	F	-	--
Dock, willow-leaved	Rumex mexicanus	P	N	F	I	--
Dogbane, spreading	Apocynum androsaemifolium	P	N	F	-	--
Dropseed, prairie	Sporobolus heterolepis	P	N	G	D	Mid-grass
Dropseed, sand	Sporobolus cryptandrus	P	N	G	I	Mid-grass
Dropseed, tall	Sporobolus asper	P	N	G	D	Mid-grass
Elder, marsh	Iva xanthifolia	A	N	F	IV	--

(continues)

Common Name	Scientific Name[1]	Longevity[2]	Origin[3]	Life Form[4]	Response to Grazing[5]	Comments
Elm, American	Ulmus americana	-	N	W	-	Tree
Elm, Chinese	Ulmus parvifolia	-	I	W	-	Tree
Elm, Siberian	Ulmus pumila	-	I	W	-	Tree
Eriogonum, yellow	Eriogonum flavum	P	N	F	-	Half-shrub
Fescue, six-weeks	Festuca octoflora	A	N	G	IV	Short-grass
Flax, common	Linum usitatissimum	A	-	F	-	Crop species
Flax, Lewis' wild	Linum lewisii	P	N	F	D	--
Flax, stiffstem	Linum rigidum	A	N	F	IV	--
Fleabane, daisy	Erigeron sp.	-	N	F	-	--
Frenchweed	Thlaspi arvense	A	N	F	IV	--
Gaura	Gaura coccinea	P	N	F	-	--
Goatsbeard, large	Tragopogon dubius	B	N	F	-	--
Goldenrod, early	Solidago missouriensis	P	N	F	-	--
Goldenrod, giant	Solidago gigantea	P	N	F	-	--
Goldenrod, soft	Solidago mollis	P	N	F	D	--
Goldenrod, stiff	Solidago rigida	P	N	F	I	--
Goldenrod, tall	Solidago altissima	P	N	F	-	--
Gooseberry, Missouri	Ribes missouriense	-	N	W	-	Low shrub
Grama, blue	Bouteloua gracilis	P	N	G	I	Short-grass
Grama, side-oats	Bouteloua curtependula	P	N	G	D	Mid-grass
Grass, indian	Sorghastrum nutans	P	N	G	D	Tall-grass
Porcupine, porcupine	Stipa spartea	P	N	G	D	Tall-grass
Grass, western porcupine	Stipa spartea (var.)	P	N	G	D	Mid-grass
Gumweed	Grindelia squarrosa	B	N	F	IV	--
Hawthorn, round-leaved	Crataegus rotundifolia	-	N	W	-	High shrub
Hemp, indian	Apocynum sibiricum	P	N	F	-	--
Honeysuckle	Lonicera sp.	-	I	W	-	High shrub
Horsetail, Kansas	Equisetum kansanum	-	N	-	-	Spore-bearing
Indigo, dwarf wild	Amorpha nana	-	N	W	-	Low shrub
Ironweed, cut-leaved	Aplopappus spinulosus	P	N	F	I	--
Ivy, poison	Rhus radicans	-	N	W	-	Low shrub
Juneberry	Amelanchier alnifolia	-	N	W	-	High shrub
Junegrass, prairie	Koeleria cristata	P	N	G	D	Mid-grass
Juniper, Rocky Mountain	Juniperus scopulorum	-	N	W	-	High shrub
Juniper, trailing	Juniperus horizontalis	-	N	W	-	Trailing shrub
Kinghead	Ambrosia trifida	A	N	F	-	--
Knotweed	Polygonum sp.	A	N	F	-	--
Lamb's-quarter	Chenopodium album	A	N	F	IV	--
Leadplant	Amorpha canescens	-	N	W	D	Low shrub, legume
Lettuce, blue wild	Lactuca pulchella	P	N	F	D	--
Lettuce, prickly	Lactuca serriola	A	N	F	D	--
Licorice, wild	Glycyrrhiza lepidota	P	N	F	-	Legume
Lilac	Syringa vulgaris	-	I	W	-	High shrub
Loco, purple	Oxytropes lambertii	P	N	F	I	Legume
Lupine, false	Thermopsis rhombifolia	P	N	F	I	Legume
Mallow, red	Sphaeralcea coccinea	P	N	F	I	--
Manna grass, American	Glyceria grandis	P	N	G	D	Tall-grass
Meadowgrass, salt	Puccinellia nuttalliana	P	N	G	D	Mid-grass
Milkvetch, striate	Astragalus striatus	P	N	F	-	Legume
Milkvetch, tufted	Astragalus triphyllus	P	N	F	-	Legume
Milkweed, common	Asclepias syriaca	P	N	F	-	--
Milkweed, whorled	Asclepias verticillata	P	N	F	I	--
Milkwort, white	Polygala alba	P	N	F	D	--
Mint, wild	Mentha arvensis	P	N	F	-	--
Muhly, marsh	Muhlenbergia racemosa	P	N	G	D	Mid-grass
Muhly, mat	Muhlenbergia richardsonis	P	N	G	I	Short-grass
Muhly, plains	Muhlenbergia cuspidata	P	N	G	D	Short-grass
Mustard, tansy	Descurainia sp.	A	N	F	IV	--
Needle-and-thread	Stipa comata	P	N	G	I	Mid-grass
Needlegrass, green	Stipa viridula	P	N	G	D	Mid-grass
Oats	Avena sativa	-	-	-	-	Crop species
Oats, spike	Avena hookeri	P	N	G	-	Mid-grass
Oats, wild	Avena fatua	A	I	G	-	--
Olive, Russian	Euonymus angustifolia	-	I	W	-	High shrub
Onion, white wild	Allium textile	P	N	F	-	--
Osier, red	Cornus stolonifera	-	N	W	-	High shrub
Panicum, Wilcox	Panicum wilcoxianum	P	N	G	D	Short-grass
Parsley, wild	Musineon divaricatum	P	N	F	-	--
Parsnip, meadow	Zizia aptera	P	N	F	-	--
Parsnip, water	Sium suave	P	N	F	-	--
Pasque-flower	Anemone patens	P	N	F	-	--
Pennyroyal, rough	Hedeoma hispida	A	N	F	IV	--
Peppergrass	Lepidium densiflorum	A	N	F	IV	--
Phlox, moss	Phlox hoodii	P	N	F	I	--
Pine, ponderosa	Pinus ponderosa	-	N	W	-	Tree
Plantain, alkali	Plantago eriopoda	P	N	F	I	--
Plantain, Pursh's	Plantago purshii	A	N	F	IV	--
Plantain, water	Alisma subcordatum	P	N	F	-	Emergent aquatic
Plum, ground	Astragalus caryocarpus	P	N	F	-	Legume
Plum, wild	Prunus americana	-	N	W	-	High shrub
Pondweed, sago	Potamogeton pectinatus	-	N	-	-	Submerged aquatic
Poverty weed	Iva axillaris	P	N	F	-	--
Prickly pear, brittle	Opuntia fragilis	P	N	-	I	--
Prickly pear	Opuntia polyacantha	P	N	-	I	--
Primrose, tooth-leaved evening	Oenothera serrulata	P	N	F	-	Half shrub
Quackgrass	Agropyron repens	P	I	G	IV	Mid-grass
Rabbitbrush	Chrysothamnus graveolens	-	N	W	I	Low shrub
Ragweed, perennial	Ambrosia coronapifolia	P	N	F	I	--
Redtop	Agrostis alba	P	I	G	IV	Mid-grass
Reed-canarygrass	Phalaris arundinacea	P	N	G	D	Tall-grass

(continued)

Common Name	Scientific Name[1]	Longevity[2]	Origin[3]	Life Form[4]	Response to Grazing[5]	Comments
Reedgrass, northern	Calamagrostis inexpansa	P	N	G	D	Mid-grass
Reedgrass, plains	Calamagrostris montanensis	P	N	G	D	Short-grass
Rivergrass	Scolochloa festucacea	P	I	G	D	Tall-grass
Rockcress, Holboell	Arabis holboellii	-	N	F	--	--
Rose, prairie wild	Rosa arkansana	-	N	W	I	Low shrub
Rose, western wild	Rosa woodsii	-	N	W	I	Low shrub
Rush, Baltic	Juncus balticus	P	N	-	IV	--
Sage, fringed	Artemisia frigida	P	N	F	I	Half-shrub
Sage, green	Artemisia glauca	P	N	F	I	--
Sage, white	Artemisia ludoviciana	P	N	F	-	--
Sagebrush, silver	Artemisia cana	-	N	W	I	Low shrub
Saltbush, hastate	Atriplex hastata	P	N	F	-	--
Saltgrass	Distichlis stricta	P	N	G	I	Short-grass
Sandgrass, big	Calamovilfa longifolia	P	N	G	D	Tall-grass
Scratchgrass	Muhlenbergia asperifolia	P	N	G	I	Short-grass
Seablite	Suaeda depressa	A	N	F	IV	--
Sedge, fescue	Carex brevior	P	N	S	D	--
Sedge, long-beaked	Carex sprengelii	P	N	S	-	--
Sedge, needleaf	Carex eleocharis	P	N	S	I	--
Sedge, Pennsylvania	Carex pennsylvanica	P	N	S	I	--
Sedge, Sartwell	Carex sartwellii	P	N	S	-	--
Sedge, slim	Carex praegracilis	P	N	S	I	--
Sedge, slough	Carex atherodes	P	N	S	D	--
Sedge, smoothcone	Carex laeviconica	P	N	S	-	--
Sedge, threadleaf	Carex filifolia	P	N	S	I	--
Sedge, wooly	Carex lanuginosa	P	N	S	D	--
Silverberry	Elaeagnus argentia	-	N	W	I	Low shrub
Silverleaf	Psoralia argophylla	P	N	F	-	Legume
Skeletonweed	Lygodesmia juncea	P	N	F	I	--
Skunkbush	Rhus trilobata	-	N	W	-	Low shrub
Sloughgrass, American	Beckmannia syzigachne	A	N	G	IV	Mid-grass
Smartweed, long-rooted	Polygonum coccineum	P	N	F	-	--
Sorrel, upright yellow-wood	Oxalis stricta	A	N	F	IV	--
Sowthistle, spiny	Sonchus asper	A	N	F	-	--
Spikemoss	Selaginella densa	-	-	-	-	Spore bearing
Spikerush, common	Eleocharis palustris	P	N	S	I	--
Spikerush, needle	Eleocharis acicularis	P	N	S	I	--
Spurge	Euphorbia sp.	-	N	F	-	--
Star, evening	Mentzelia decapetala	B	N	F	-	--
Star, narrow-leaved blazing	Liatris punctata	P	N	F	D	--
Stickseed	Hackelia americana	B	N	F	-	--
Sunflower, common	Helianthus annuus	A	N	F	IV	--
Sunflower, narrow-leaved	Helianthus maximiliani	P	N	F	D	--
Sunflower, Rydberg's	Helianthus rydbergii	P	N	F	D	--
Sunflower, stiff	Helianthus rigidus	P	N	F	D	--
Switchgrass	Panicum virgatum	P	N	G	D	Tall-grass
Threeawn, red	Aristida longiseta	P	N	G	I	Short-grass
Thistle, bull	Cirsium vulgare	B	N	F	IV	--
Thistle, prairie	Cirsium undulatum	P	N	F	I	--
Ticklegrass	Agrostis scabra	P	N	G	IV	Short-grass
Toadflax, bastard	Commandra pallida	P	N	F	-	--
Trefoil, prairie bird's-foot	Lotus americanus	A	N	F	IV	Legume
Tumblegrass	Schedonnardus paniculatus	P	N	G	IV	Short-grass
Vervain, swamp	Verbena hostata	P	N	F	-	--
Vetch, American	Vicia americana	P	N	F	D	Legume
Vetch, prairie	Vicia sparsifolia	P	N	F	D	Legume
Wallflower, western	Erysimum asperum	B	N	F	-	--
Wedgegrass, prairie	Sphenopholis obtusata	P	N	G	D	Mid-grass
Wheat	Triticum aestivum	A	-	G	-	Crop species
Wheatgrass, bearded	Agropyron subsecundum	P	N	G	D	Mid-grass
Wheatgrass, crested	Agropyron cristatum	P	I	G	-	Hay grass
Wheatgrass, Montana	Agropyron albican	P	N	G	D	Mid-grass
Wheatgrass, slender	Agropyron trachycaulum	P	N	G	D	Mid-grass
Wheatgrass, thickspike	Agropyron dasystachyum	P	N	G	D	Mid-grass
Wheatgrass, western	Agropyron smithii	P	N	G	D	Mid-grass
Whitlowwort	Paronychia sessiliflora	P	N	F	-	--
Wild-rye, Canada	Elymus canadensis	P	N	G	D	Tall-grass
Wild-rye, Macoun	Elymus macounii	P	N	G	D	Mid-grass
Wild-rye, Virginia	Elymus virginius	P	N	G	D	Mid-grass
Willow, golden	Salix alba Var. vitellina	-	I	W	-	Tree
Willow, heart-leaved	Salix cordata	-	N	W	-	High shrub
Willow, laurel-leaved	Salix pentandra	-	I	W	-	Tree
Willow, Missouri	Salix missouriensis	-	N	W	-	High shrub
Willow, peach-leaved	Salix amygdaloidia	-	N	W	-	Tree
Willow, pussy	Salix discolor	-	N	W	-	High shrub
Willow, sandbar	Salix interior	-	N	W	-	High shrub
Winterfat	Eurotia lanata	P	N	F	-	Half-shrub
Wolfberry	Symphoricarpos occidentalis	-	N	W	-	Low shrub
Yarrow	Achillea lanulosa	P	N	F	I	--

[1] According to Stevens (1963)

[2] A = Annual, B = Biennial, P = Perennial

[3] N = Native, I = Introduced

[4] G = Grass, S = Sedge (Grass-like), F = Forb, W = Woody

[5] I = Increaser, D = Decreaser, IV = Invader; according to U.S.D.A. Soil Conservation Service, 1957 (Unpublished).

Compiled by: Woodward-Knvicon, Inc., 1974.

BOTANICAL COMPOSITION (PERCENT[1]) OF FENCEROW PLANT COMMUNITIES AS DETERMINED BY THE PACE-POINT METHOD

Species	Sample Number 1	2	3	4	5	6	7	8	9	Average
Introduced Grasses										
Smooth brome	87	55	11	69	T	25	1	14	3	29
Kentucky bluegrass	4	11	1	3	60	22	44	56	10	23
Crested wheatgrass	--	T	--	15	4	45	1	--	--	7
Total	91	66+	12	87	64+	92	46	70	13	60
Native Perennial Grasses										
Western wheatgrass	--	1	9	--	14	6	24	13	18	9
Slender wheatgrass	--	6	1	--	T	--	1	--	6	2
Green needlegrass	--	--	--	--	1	--	6	1	3	1
Prairie junegrass	--	--	--	--	9	--	--	--	--	1
Wild barley	--	4	--	--	--	--	--	--	--	T
Blue grama	--	--	--	--	3	--	--	--	--	T
Needle-and-thread	--	--	--	--	2	--	--	--	--	T
Total	--	12	11	--	29+	6	31+	14	27+	14
Sedges										
Pennsylvania sedge	1	--	--	--	2	--	T	--	4	1
Smoothcone sedge	--	--	T	1	--	--	T	--	--	T
Total	1	--	T	1	2	--	T	--	4	1
Perennial Forbs and Half-shrubs										
Alfalfa	1	12	--	--	1	T	--	--	--	1
Field Bindweed	4	--	1	1	--	T	--	1	1	1
Long-rooted smartweed	--	--	--	3	--	--	--	--	--	T
Jerusalum artichoke	--	--	1	T	--	--	--	--	--	T
Prairie vetch	--	--	--	--	T	--	--	--	1	T
Total	6	14+	3	4+	2+	T	T	1+	3+	3

Species	Sample Number 1	2	3	4	5	6	7	8	9	Average
Annuals and Biennials										
Burningbush	3	1	37	--	--	--	10	3	6	7
Wild oat	--	--	16	--	--	--	2	1	8	3
Wild buckwheat	--	--	2	--	T	--	1	2	16	2
Tansy mustard	1	--	4	--	--	--	3	5	2	2
Spiny sowthistle	1	T	1	1	T	--	1	--	9	1
Kinghead	--	--	1	T	--	--	--	7	--	1
Large goatsbeard	--	1	1	--	1	--	T	--	2	1
Frenchweed	--	--	1	T	--	--	--	7	--	1
Lamb's quarter	--	--	1	T	--	--	--	--	3	T
Collomia	--	--	1	--	--	--	--	--	1	T
Total	5	3+	66+	1+	2+	--	17+	26	48+	19
Woody Plants										
Wolfberry	1	--	2	--	--	--	--	--	--	T
Prairie wild rose	--	T	--	T	--	--	--	--	--	T
Total	1	T	2	T	--	--	--	--	--	T

1 Percentages less than 1.0 are listed as trace (T).

Source: Woodward-Envicon, Inc., 1974

PLANT COMMUNITY COMPOSITION OF SUBIRRIGATED RANGE SITE

Species	Estimated Percent By Weight[1,3]
Grasses	
Big bluestem	35
Prairie cordgrass	30
Switchgrass	20
Slender wheatgrass	5
Wild barley ("Foxtail")	3
Canada wild-rye	2
Perennial Forbs	
Narrow-leaved sunflower	3
Common milkweed Water parsnip White prairie aster Whorled milkweed Wild bergamot	2
Annual Forbs	
Prickly lettuce	T
Miscellaneous	
Kansas horsetail	T

[1]Inclusion in "Amor-Werner loams" mapping unit.

[2]Extent of this range site was insufficient for sampling.

[3]Percentages less than 1.0 are listed as trace (T).

Source: Woodward-Envicon, Inc., Analysis, 1974.

BOTANICAL COMPOSITION (PERCENT[1]) OF THE OVERFLOW RANGE SITE PLANT COMMUNITY AS DETERMINED BY THE PACE-POINT METHOD

Species	Sample 1[2]	Sample 2[3]	Average
Grasses			
Big bluestem	33	53	43
Porcupine grass	12	2	7
Kentucky bluegrass	6	7	6.5
Marsh muhly	--	7	3.5
Bearded wheatgrass	2	2	2.0
Fowl bluegrass	--	4	2.0
Canada wild-rye	--	1	0.5
Green needlegrass	1	--	0.5
Prairie cordgrass	--	1	0.5
Prairie junegrass	1	--	0.5
Mat muhly	T	--	T
Ticklegrass	--	T	T
Western wheatgrass	T	--	T
Sedges			
Pennsylvania sedge	26	7	16.5
Fescue sedge	T	5	2.5+
Smoothcone sedge	--	3	1.5
Perennial Forbs			
Prairie thistle	3	--	1.5
Wild bergamot	3	--	1.5
Yarrow	2	--	1.0
Canada anemone	1	--	0.5
Northern bedstraw	1	--	0.5
Skeletonweed	1	--	0.5
Soft goldenrod	1	--	0.5
White sage	1	--	0.5
Blue wild lettuce	T	--	T
Ground cherry	T	--	T
Prairie chickweed	T	--	T
Stiff sunflower	--	T	T
Tall goldenrod	T	--	T
Annual Forbs			
Upright yellow wood sorrel	--	1	0.5
Spurge	T	--	T
Woody Plants			
Wolfberry	3	--	1.5
Prairie wild rose	1	--	0.5
Miscellaneous			
Kansas horsetail	--	2	1.0

[1]Percentages less than 1.0 are listed as trace (T).

[2]Inclusion in "Channeled Straw and Korchea Soils" mapping unit: average of three transects.

[3]Inclusion in "Cohagen-Vebar fine sandy loams" mapping unit; average of two transects.

Source: Woodward-Envicon, Inc., Analysis, 1974.

PLANT COMMUNITY COMPOSITION OF A SALINE LOWLAND RANGE SITE[1] IN A MODERATELY WELL DRAINED AREA

Species	Estimated Percent By Weight[2]
Grasses	
Western wheatgrass	60
Swallen bluegrass	20
Perennial Forbs	
Gumweed	2
Fringed sage	1
Annual and Biennial Forbs	
Povertyweed	15
Large goatsbeard	1
Miscellaneous	
Brittle prickly pear	1

[1]Harriet clay.

[2]Extent of this range site was insufficient for sampling.

Source: Woodward-Envicon, Inc., Analysis, 1974.

PLANT COMMUNITY COMPOSITION OF A SALINE LOWLAND RANGE SITE[1] IN A POORLY DRAINED AREA

Species	Estimated Percent By Weight[2,3]
Grasses	
Salt meadowgrass	25
Saltgrass	20
Western wheatgrass	10
Wild barley ("Foxtail")	10
Swallen bluegrass	5
Sedges	
Prairie bulrush	5
Common spikerush	T
Annual Forbs	
Hastate saltbush	20
Knotweed	3
Peppergrass	1
Pursh's plantain	1

[1]Harriet clay.

[2]Extent of this range site was insufficient for sampling

[3]Percentage less than 1.0 are listed as trace (T).

Source: Woodward-Envicon, Inc. Analyses, 1974.

BOTANICAL COMPOSITION (PERCENT[1]) OF SANDY RANGE SITE PLANT COMMUNITY AS DETERMINED BY THE PACE-POINT METHOD

Species	Sample 1[2]	Sample 2[3]	Average
Grasses			
Big sandgrass	14	19	16.5
Prairie junegrass	8	13	10.5
Blue grama	11	8	9.5
Needle-and-thread	8	9	8.5
Red threeawn	8	4	6.0
Wilcox panicum	4	4	4.0
Porcupine grass	2	2	2.0
Plains muhly	2	1	1.5
Western wheatgrass	2	T	1.0+
Little bluestem	1	T	0.5+
Kentucky bluegrass	1	--	0.5
Green needlegrass	1	--	0.5
Bearded wheatgrass	T	--	T
Side-oats grama	--	T	T
Sedges			
Pennsylvania sedge	21	18	19.5
Threadleaf sedge	2	1	1.5
Perennial Forbs and Half-shrubs			
White sage	2	3	2.5
Stiff sunflower	1	3	2.0
Blue wild lettuce	2	1	1.5
Skeletonweed	1	2	1.5
Fringed sage	T	2	1.0+
Purple loco	T	2	1.0+
Silverleaf	T	2	1.0+
Soft goldenrod	1	1	1.0
Golden aster	T	1	0.5+
Green sage	T	1	0.5+
Pasque-flower	1	T	0.5+
Prairie chickweed	1	T	0.5+
Purple coneflower	1	T	0.5+
Bastard toadflax	1	--	0.5
White prairie aster	1	--	0.5
Perennial Forbs and Half-shrubs (cont'd.)			
Prairie thistle	--	1	0.5
Early goldenrod	T	T	T
Daisy fleabane	T	--	T
Narrow-leaved blazing star	T	--	T
Stiff goldenrod	T	--	T
Wild licorice	--	T	T
Yarrow	T	--	T
Annual Forbs			
Owl clover	--	T	T
Woody Plants			
Prairie wild rose	1	2	1.5

[1]Percentages less than 1.0 are listed as trace (T).

[2]Vebar fine sandy loam; average of four transects.

[3]Vebar fine sandy loam; average of three transects.

Source: Woodward-Envicon, Inc. Analysis, 1974.

BOTANICAL COMPOSITION (PERCENT[1]) OF THE SILTY RANGE SITE PLANT COMMUNITY AS DETERMINED BY THE PACE-POINT METHOD

Species	Sample 1[2]	Sample 2[3]	Average
Grasses			
Blue grama	12	17	14.5
Western wheatgrass	9	10	9.5
Needle-and-thread	4	10	7.0
Prairie junegrass	5	6	5.5
Thickspike wheatgrass	9	1	5.0
Green needlegrass	5	2	3.5
Porcupine grass	6	T	3.0+
Red threeawn	2	2	2.0
Kentucky bluegrass	1	--	1.5
Plains muhly	1	2	1.5
Saltgrass	1	--	0.5
Side-oats grama	--	1	0.5
Plains reedgrass	T	--	T
Sandberg bluegrass	T	--	T
Ticklegrass	T	--	T
Sedges			
Pennsylvania sedge	19	12	15.5
Needleleaf sedge	1	9	5.0
Threadleaf sedge	3	3	3.0
Perennial Forbs and Half-shrubs			
Fringed sage	3	3	3.0
Blue wild lettuce	T	4	2.0+
Green sage	1	2	1.5
White prairie aster	1	2	1.5
Stiff goldenrod	--	3	1.5
White sage	2	1	1.5
Striate milkvetch	--	2	1.0
Aromatic aster	T	1	0.5+
Daisy fleabane	1	T	0.5+
Moss phlox	T	1	0.5+
Perennial Forbs and Half-Shrubs (cont'd.)			
Silverleaf	T	1	0.5+
Soft goldenrod	1	T	0.5+
Catsfoot	--	1	0.5
Narrow-leaved blazing star	--	1	0.5
Prairie chickweed	1	--	0.5
Red mallow	--	1	0.5
Yarrow	1	--	0.5
Early goldenrod	T	T	T
Prairie thistle	T	T	T
Bastard toadflax	--	T	T
Gaura	T	--	T
Ground plum	--	T	T
Pasque-flower	T	--	T
Povertyweed	T	--	T
Prairie vetch	T	--	T
Purple coneflower	T	--	T
Stiff sunflower	--	T	T
Biennial Forbs			
Sweet clover	2	1	1.5
Large goatsbeard	1	1	1.0
Annual Forbs			
Collomia	T	--	T
Prairie bird's-foot trefoil	T	--	T
Fairy candelabra	T	--	T
Stiffstem flax	--	T	T
Woody Plants			
Prairie wild rose	T	2	1.0+
Wolfberry	--	1	0.5

[1]Percentages less than 1.0 are listed as trace (T).

[2]Graill silt loam; average of four transects.

[3]Williams loam; average of three transects.

Source: Woodward-Envicon, Inc. Analysis, 1974.

PLANT COMMUNITY COMPOSITION OF CLAYEY RANGE SITE[1]

Species	Estimated Percent by Weight[2, 3]
Grasses	
Western wheatgrass	45
Green needlegrass	15
Blue grama	10
Kentucky bluegrass	2
Prairie junegrass	T
Ticklegrass	T
Sedges	
Pennsylvania sedge	5
Perennial Forbs and Half-shrubs	
White sage	5
Silverleaf	5
White prairie aster	3
American vetch, Fringed sage, Green sage, Long-headed coneflower, Prairie thistle, Soft goldenrod, Yarrow	5
Annual Forbs	
Prairie bird's-foot trefoil	1
Owl clover	1
Pursh's plantain	1
Woody Plants	
Prairie wild rose	1
Wolfberry	1

[1] Belfield silty clay loam.

[2] Extent of this range site was insufficient for sampling.

[3] Percentages less than 1.0 are listed as trace (T).

Source: Woodward-Envicon, Inc. Analysis, 1974.

BOTANICAL COMPOSITION (PERCENT[1]) OF THIN UPLAND RANGE SITE PLANT COMMUNITY AS DETERMINED BY THE PACE-POINT METHOD

Species	Sample 1[2]	Sample 2[2]	Average
Grasses			
Little bluestem	30	31	30.5
Porcupine grass	5	4	4.5
Big sandgrass	1	7	4.0
Prairie junegrass	5	2	3.5
Kentucky bluegrass	T	6	3.0+
Blue grama	3	3	3.0
Needle-and-thread	4	T	2.0+
Plains muhly	1	2	1.5
Red threeawn	1	2	1.5
Thickspike wheatgrass	--	2	1.0
Green needlegrass	--	1	0.5
Spike oat	--	1	0.5
Western wheatgrass	T	--	T
Sedges			
Pennsylvania sedge	11	12	12.5
Threadleaf sedge	4	5	4.5
Perennial Forbs and Half-shrubs			
Stiff sunflower	4	0	2.0
Pasque-flower	3	T	1.5+
Prairie chickweed	2	1	1.5
Prairie thistle	--	3	1.5
Silverleaf	1	2	1.5
White prairie aster	1	2	1.5
Bluebell	2	T	1.0+
Narrow-leaved blazing star	2	T	1.0+
Blue wild lettuce	1	1	1.0
Broomweed	1	1	1.0
Fringed sage	1	1	1.0
Northern bedstraw	--	2	1.0
Purple coneflower	2	--	1.0
Catsfoot	1	T	0.5+
Long-headed coneflower	1	T	0.5+
Purple prairie clover	T	1	0.5+
Aromatic aster	1	--	0.5
Green sage	1	--	0.5
Indian breadroot	1	--	0.5
Moss phlox	1	--	0.5
Prairie vetch	--	1	0.5
Striate milkvetch	--	1	0.5
White sage	1	--	0.5
Early goldenrod	T	T	T
Alumroot	T	--	T
Cottonweed	T	--	T
Purple loco	T	--	T
Skeletonweed	T	--	T
Yarrow	T	--	T
Annual Forbs			
Prairie bird's-foot trefoil	T	--	T
Rough pennyroyal	T	--	T
Woody Plants			
Prairie wild rose	1	T	0.5+
Dwarf wild indigo	1	--	0.5

[1] Percentages less than 1.0 are listed as trace (T).

[2] Zahl silt loam; average of three transects.

Source: Woodward-Envicon, Inc. Analysis, 1974.

BOTANICAL COMPOSITION (PERCENT[1]) OF SHALLOW RANGE SITE PLANT COMMUNITY AS DETERMINED BY THE PACE-POINT METHOD

Species	Sample 1[2]	Sample 2[3]	Average
Grasses			
Little bluestem	18	16	17
Big sandgrass	7	6	6.5
Red threeawn	6	6	6.0
Needle-and-thread	5	4	4.5
Blue grama	5	3	4.0
Prairie junegrass	2	2	2.0
Porcupine grass	2	1	1.5
Wilcox panicum	2	1	1.5
Plains muhly	2	--	1.0
Green needlegrass	1	T	0.5+
Thickspike wheatgrass	--	1	0.5
Kentucky bluegrass	T	--	T
Sedges			
Threadleaf sedge	13	12	12.5
Pennsylvania sedge	11	13	12.0
Perennial Forbs and Half-shrubs			
Stiff sunflower	3	7	5.0
Purple coneflower	6	3	4.5
Aromatic aster	1	3	2.0
Prairie thistle	T	3	1.5+
Bastard toadflax	2	1	1.5
Green sage	1	2	1.5
Pasque-flower	3	--	1.5
White prairie aster	1	2	1.5
Blue wild lettuce	T	2	1.0+
Fringed sage	1	1	1.0
Narrow-leaved blazing star	T	1	0.5+
False boneset	--	1	0.5
Early goldenrod	T	T	T
Golden aster	T	T	T
Striate milkvetch	T	T	T
Perennial Forbs and Half-shrubs (cont'd)			
Purple prairie clover	T	T	T
White sage	T	T	T
False lupine	--	T	T
Indian breadroot	--	T	T
Long-headed coneflower	T	--	T
Gaura	T	--	T
Silverleaf	T	--	T
Skeletonweed	T	--	T
Green sage	T	--	T
Biennial Forbs			
Bull thistle	--	T	T
Large goatsbeard	--	T	T
Annual Forbs			
Prairie bird's-foot trefoil	--	T	T
Woody Plants			
Prairie wild rose	1	1	1.0

[1] Percentages less than 1.0 are listed as trace (T).

[2] Cohagen fine sandy loam; average of four transects.

[3] Cabba-Werner complex; average of three transects.

Source: Woodward-Envicon, Inc. Analysis, 1974.

PLANT COMMUNITY COMPOSITION OF A CLAYPAN RANGE SITE[1]

Species	Estimated Percent By Weight[2,3]
Grasses	
Western wheatgrass	40
Green needlegrass	12
Prairie junegrass	10
Blue grama	5
Needle-and-thread	5
Kentucky bluegrass	2
Red threeawn	T
Six-weeks fescue	T
Sedges	
Pennsylvania sedge	8
Threadleaf sedge	5
Needleleaf sedge	T
Perennial Forbs and Half-shrubs	
Fringed sage	2
Green sage	2
Cut-leaved ironweed, Indian breadroot, Narrow-leaved blazing star, Red mallow, Silverleaf, Skeletonweed, White sage	6
Annual and Biennial Forbs	
Collomia, Rough pennyroyal, Peppergrass, Pursh's plantain, Sweet clover	2
Miscellaneous	
Brittle prickly pear	T

[1] Savage clay loam.

[2] Extent of this range site was insufficient for sampling.

[3] Percentages less than 1.0 are listed as trace (T).

Source: Woodward-Envicon, Inc. Analysis, 1974.

PLANT COMMUNITY COMPOSITION OF A SHALLOW TO GRAVEL RANGE SITE[1]

Species	Estimated Percent By Weight[2]
Grasses	
Blue grama	20
Needle-and-thread	8
Western wheatgrass	5
Prairie junegrass	2
Sedges	
Threadleaf sedge	25
Pennsylvania sedge	5
Perennial Forbs and Half-shrubs	
Fringed sage	10
Silverleaf	8
Golden aster	5
Green sage	5
Gumweed	5
Catsfoot, Long-headed coneflower, Pasque-flower, Skeletonweed, Yarrow	2

[1] Lehr loam.

[2] Extent of this range site was insufficient for sampling.

Source: Woodward-Envicon, Inc. Analysis, 1974.

PLANT COMMUNITY COMPOSITION OF A VERY SHALLOW RANGE SITE UNDERLAIN BY GRAVEL[1]

Species	Estimated Percent By Weight[2,3]
Grasses	
Needle-and-thread	25
Blue grama	8
Prairie junegrass	5
Little bluestem	T
Sedges	
Threadleaf sedge	30
Needleleaf sedge	2
Perennial Forbs and Half-shrubs	
Fringed sage	8
Broomweed	4
Golden aster	3
Green sage	3
Silverleaf	2
Narrow-leaved blazing star	2
Skeletonweed	2
Bull thistle, Moss phlox, Purple coneflower, Purple prairie clover, White milkwort	2
Annual and Biennial Forbs	
Biennial wormwood, Collomia, Rough pennyroyal, Large goatsbeard	2
Woody Plants	
Prairie wild rose	2

[1] Wabek soils.

[2] Extent of this range site was insufficient for sampling.

[3] Percentages less than 1.0 are listed as trace (T).

Source: Woodward-Envicon, Inc. Analysis, 1974.

PLANT COMMUNITY COMPOSITION OF A VERY SHALLOW RANGE SITE UNDERLAIN BY SANDSTONE[1]

Species	Estimated Percent By Weight[2,3]
Grasses	
Thickspike wheatgrass	35
Plains muhly	2
Prairie junegrass	2
Plains reedgrass	1
Sedges	
Threadleaf sedge	3
Pennsylvania sedge	2
Perennial Forbs and Half-shrubs	
False lupine	15
Fringed sage	15
Broomweed	6
Golden aster, Pasque-flower, Purple coneflower, Purple loco, Tufted milkvetch, Yellow eriogonum	5
Woody Plants	
Creeping cedar	15
Miscellaneous	
Brittle prickly pear	T

[1] In portion of "Cohagen-Vebar fine sandy loams" mapping unit with sandstone outcrop.

[2] Extent of this range site was insufficient for sampling.

[3] Percentages less than 1.0 are listed as trace (T).

PLANT COMMUNITY COMPOSITION OF A VERY SHALLOW RANGE SITE UNDERLAIN BY CLINKER[1]

Species	Estimated Percent By Weight[2,3]
Plains muhly	30
Needle-and-thread	20
Little bluestem	15
Blue grama	5
Sedges	
Threadleaf sedge	10
Perennial Forbs and Half-shrubs	
Stiff sunflower	4
Fringed sage	2
Purple coneflower	1
Tooth-leaved evening primrose	1
Bastard toadflax, Bluebell, Early goldenrod, Evening star, Narrow-leaved blazing star	7
Purple prairie clover, Red mallow, Western wallflower, Yellow eriogonum	
Annual Forbs	
Collomia, Prairie bird's-foot trefoil, Stiffstem flax	2
Woody Plants	
Prairie wild rose	1
Sand cherry	1
Miscellaneous	
Prickly pear	1
White wild onion	T

[1] Ringling loam.

[2] Extent of this range site was insufficient for sampling.

[3] Percentages less than 1.0 are listed as trace (T).

Source: Woodward-Envicon, Inc., Analysis, 1974.

PLANT COMMUNITY COMPOSITION OF THIN CLAYPAN RANGE SITE[1]

Species	Estimated Percent By Weight[2,3]
Grasses	
Western wheatgrass	45
Blue grama	10
Tumblegrass	10
Buffalograss	5
Sandberg bluegrass	5
Kentucky bluegrass	3
Prairie junegrass	2
Green needlegrass	T
Needle-and-thread	T
Perennnial Forbs and Half-shrubs	
Gumweed	10
Fringed sage	3
Long-headed coneflower	2
Red mallow	2
Yarrow	1
Annual Forbs	
Prairie bird's-foot trefoil Rough pennyroyal Peppergrass Pursh's plantain	2
Miscellaneous	
Brittle prickly pear	T

[1]Rhoades clay loam.

[2]Extent of this range site was insufficient for sampling.

[3]Percentages less than 1.0 are listed as trace (T).

Source: Woodward-Envicon, Inc., Analysis, 1974.

BOTANICAL COMPOSITION (PERCENT[1]) OF THE WET MEADOW RANGE SITE PLANT COMMUNITY AS DETERMINED BY THE PACE-POINT METHOD

Species	Sample 1[2]	Sample 2[3]	Average
Grasses			
Wild barley ("Foxtail")	16	3	9.5
Prairie wedgegrass	T	13	6.5+
Fowl bluegrass	5	1	3.0
American sloughgrass	T	5	2.5+
Prairie cordgrass	3	--	1.5
Sedges			
Smoothcone sedge	60	44	52.0
Common spikerush	3	32	18.0
Needle spikerush	T	2	1.0+
Perennial Forbs			
Tall white aster	4	--	2.0
Willow-leaved dock	2	--	1.0
Spreading dogbane	T	--	T
Annual Forbs			
Spiny sowthistle	1	--	0.5

[1]Percentage less than 1.0 are listed as trace (T).

[2]Inclusion in "Dimmick silty clay" mapping unit; average of two transects.

[3]Inclusion in "Parnell silt loam" mapping unit; average of two transects.

Source: Woodward-Envicon, Inc., Analysis, 1974.

BOTANICAL COMPOSITION (PERCENT[1]) OF WETLAND RANGE SITE PLANT COMMUNITY AS DETERMINED BY THE PACE-POINT METHOD

Species	Sample 1[2]	Sample 2[3]	Average
Slough sedge	56	83	69.0
Long-rooted smartweed	39	11	25.0
Smoothcone sedge	1	3	2.0
Broad-leaved cattail	3	--	1.5
Northern reedgrass	--	3	1.5
Rivergrass	--	1	0.5
Burreed	T	--	T

[1]Percentages less than 1.0 are listed as trace (T).

[2]Parnell silt loam; average of two transects.

[3]Inclusion in "Marsh" mapping unit; one transect.

Source: Woodward-Envicon, Inc., Analysis, 1974.

BOTANICAL COMPOSITION (PERCENT) OF THE MARSH PLANT COMMUNITY AS DETERMINED BY THE PACE-POINT METHOD

Species	Sample 1[1]	Sample 2[1]	Average
Burreed	60	34	47.0
Long-rooted smartweed	27	32	29.5
Broad-leaved cattail	--	25	12.5
River bulrush	13	--	6.5
Wedgegrass	--	3	1.5
Arrowhead	--	2	1.0
Common spikerush	--	2	1.0
Water plantain	--	2	1.0

[1]Average of two transects.

Source: Woodward-Envicon, Inc., Analysis, 1974.

WOODY PLANT COMMUNITIES OCCURRING IN HYDRIC, MESIC AND XERIC MOISTURE SITUATIONS

Hydric	Mesic	Xeric
Box-elder	American elm	Buffaloberry
Cottonwood	Choke cherry	Wolfberry
Heart-leaved willow	Green ash	
Missouri willow	Juneberry	
Peach-leaved willow	Missouri gooseberry	
Pussy willow	Poison ivy	
Red osier	Quaking aspen	
Sandbar willow	Round-leaved hawthorn	
	Western wild rose	
	Wild black currant	
	Wild plum	
	Wolfberry	
	Virginia creeper	

Source: Woodward-Envicon, Inc., Analysis, 1974.

TREES AND SHRUBS ENCOUNTERED IN PLANTED WOODY STANDS

Species	Native	Exotic
American elm	X	
Box-elder	X	
Buffaloberry	X	
Caragana		X
Chinese elm		X
Choke cherry	X	
Cottonwood	X	
Green ash	X	
Golden currant	X	
Golden willow		X
Honeysuckle		X
Laurel-leaved willow		X
Lilac		X
Nanking cherry	X	
Ponderosa pine	X	
Red osier	X	
Rocky Mountain juniper	X	
Russian olive		X
Sand cherry	X	
Siberian crab		X
Siberian elm		X
Wild plum	X	

Source: Woodward-Envicon, Inc., Analysis, 1974.

NUMBER, LENGTH AND WEIGHT OF FISH COLLECTED WITH 200-FOOT EXPERIMENTAL GILL NETS FROM A DEPTH OF 100 FEET IN RENNER BAY.

Month	Species	Number	Length (mm) Min-Max	Length (mm) $\bar{x}$	Weight (g) Min-Max	Weight (g) $\bar{x}$
June	Carp	2	446 - 455	450	1134 - 1247	1190
July	Carp	1	440		794	
August	Channel catfish	1	636		2098	
September	White sucker	4	266 - 409	336	182 - 700	415

Source: Woodward-Envicon, Inc., Analysis, 1974.

NUMBER, LENGTH AND WEIGHT OF FISH COLLECTED WITH ELECTROFISHING EQUIPMENT IN RENNER BAY

Month	Species	Number	Length (mm) Min-Max	Length (mm) $\bar{x}$	Weight (g) Min-Max	Weight (g) $\bar{x}$
May	Carp	17	395 - 483	434	800 - 1400	1065
	Emerald shiner	15	40 - 93	73	0.4 - 4.8	3.4
	Walleye	12	210 - 409	298	50 - 600	266
	White sucker	11	191 - 395	344	50 - 750	498
	Yellow perch	6	64 - 146	92	4.0 - 40	13.8
	Goldeye	6	275 - 337	311	50 - 380	257
	Freshwater drum	1	424		838	
	River carpsucker	1	504		1800	
	Bigmouth buffalo	1	502		1800	
	Shorthead redhorse	1	386		1500	
	Total	71				
June	Carp	24	412 - 585	448	343 - 1600	863
	Goldeye	13	133 - 302	246	19 - 246	130
	White sucker	4	349 - 395	372	440 - 622	562
	Emerald shiner	3	74 - 88	80	4.2 - 6.7	4.9
	Walleye	2	368 - 750	559	380 - 3543	1962
	Yellow perch	1		68	3.7	
	Sauger	1		275	130	
	River carpsucker	1		542	1743	
	Total	49				
July	Carp	14	419 - 660	468	400 - 2200	796
	Goldeye	7	225 - 332	264	142 - 330	192
	Emerald shiner	4	60 - 87	68	1.7 - 6.4	3.2
	Shorthead redhorse	1	386		576	
	White bass	1	336		446	
	Yellow perch	1	189		72	
	Sauger	1	226		69	
	Total	29				
August	Goldeye	34	174 - 334	284	48 - 322	192
	Carp	19	409 - 547	441	770 - 2157	1094
	Yellow perch	10	111 - 181	145	18 - 80	44
	Walleye	6	222 - 319	287	84 - 264	165
	White sucker	5	166 - 359	232	38 - 522	166
	Freshwater drum	3	376 - 432	416	538 - 900	722
	River carpsucker	2	540	540	2214 - 2400	2307
	Northern pike	1	785		3500	
	Shorthead redhorse	1	376		538	
	White bass	1	100		14	
	Total	82				
September	Goldeye	40	276 - 350	320	164 - 380	282
	Carp	15	400 - 510	436	750 - 1685	1097
	Sauger	3	318 - 340	327	210 - 270	233
	Walleye	2	237 - 316	277	118 - 230	174
	Northern pike	1	527		792	
	White bass	1	107		20	
	Yellow perch	1	125		42	
	Total	63				
October	Goldeye	68	279 - 383	321	190 - 384	286
	River carpsucker	6	421 - 555	505	964 - 2041	1436
	Carp	4	421 - 571	482	737 - 1247	915
	Sauger	4	292 - 365	313	178 - 300	217
	Yellow perch	3	118 - 216	156	20 - 128	57
	White sucker	1	407		662	
	Walleye	1	341		340	
	Shorthead redhorse	1	391		600	
	Total	88				

Source: Woodward-Envicon, Inc., Analysis, 1974.

NUMBER, LENGTH AND WEIGHT OF FISH COLLECTED WITH GILL NETS IN RENNER BAY, LAKE SAKAKAWEA, NORTH DAKOTA

Month	Species	Number	Length (mm) Min-Max	Length (mm) X	Weight (g) Min-Max	Weight (g) X
May	Goldeye	244	273 - 415	315	124 - 558	220
	White sucker	63	266 - 445	368	172 - 1000	529
	Carp	55	382 - 565	464	700 - 2100	1343
	Walleye	38	232 - 486	328	88 - 900	379
	Sauger	33	273 - 415	315	124 - 558	220
	River carpsucker	18	437 - 619	492	1200 - 3300	2150
	Channel catfish	8	432 - 750	576	620 - 5000	3047
	Northern pike	8	690 - 978	799	1750 - 7400	3844
	Shorthead redhorse	6	339 - 441	373	379 - 744	549
	Smallmouth buffalo	3	492 - 525	509	1700 - 2100	1967
	Yellow perch	2	156 - 227	192	39 - 100	70
	Bigmouth buffalo	1	566		3000	
	Freshwater drum	1	454		1500	
	Shovelnose sturgeon	1	612		809	
	Total	481				
June	Goldeye	172	215 - 352	312	50 - 476	282
	Carp	51	372 - 555	456	800 - 2400	1243
	White sucker	23	193 - 443	348	78 - 920	477
	River carpsucker	11	479 - 542	512	1371 - 2143	1792
	Walleye	11	257 - 441	317	108 - 668	258
	Sauger	9	225 - 345	290	72 - 300	151
	Freshwater drum	3	380 - 573	430	573 - 1314	860
	Northern pike	2	679 - 764	722	2342 - 3600	2972
	Shorthead redhorse	2	391 - 472	431	622 - 1057	840
	Channel catfish	2	289 - 545	417	164 - 1371	768
	Coho salmon	1	416		730	
	Yellow perch	1	165		42	
	Total	288				
July	Goldeye	297	160 - 378	300	20 - 339	234
	Carp	40	440 - 541	463	343 - 1429	717
	Walleye	13	251 - 745	720	110 - 3800	817
	River carpsucker	9	469 - 515	480	914 - 1257	1000
	White sucker	7	252 - 391	315	160 - 578	329
	Bigmouth buffalo	3	492 - 638	562	1000 - 3257	2095
	Shorthead redhorse	3	350 - 400	381	200 - 670	435
	Channel catfish	2	257 - 291	274	118 - 164	141
	Sauger	1	553		1029	
	Smallmouth buffalo	1	556		1657	
	Freshwater drum	1	435		860	
	Total	378				
August	Walleye	36	209 - 634	380	75 - 2114	506
	Goldeye	29	170 - 332	306	164 - 430	286
	Yellow perch	23	152 - 226	197	45 - 122	90
	White sucker	17	245 - 383	320	156 - 586	355
	Carp	9	378 - 562	448	620 - 2114	1140
	Shorthead redhorse	6	334 - 410	387	378 - 725	606
	River carpsucker	5	472 - 574	517	1429 - 2514	1766
	Channel catfish	4	374 - 636	485	482 - 2114	1090
	Sauger	3	286 - 395	325	138 - 356	216
	Burbot	1	437		460	
	Freshwater drum	1	740		416	
	Total	134				
September	Goldeye	152	266 - 364	310	164 - 430	271
	Carp	31	430 - 557	474	950 - 2514	1417
	Yellow perch	26	149 - 225	201	38 - 132	92
	Walleye	16	228 - 722	392	201 - 3429	776
	White sucker	12	266 - 409	345	182 - 598	433
	Sauger	10	282 - 341	313	168 - 261	198
	River carpsucker	5	490 - 514	503	1429 - 1914	1697
	Shorthead redhorse	4	372 - 435	402	592 - 822	683
	Bigmouth buffalo	1	580		2857	
	Northern pike	1	783		3771	
	Total	258				
October	Goldeye	141	214 - 356	304	120 - 394	262
	White sucker	17	186 - 400	355	62 - 664	481
	Walleye	10	282 - 694	396	178 - 3855	870
	Carp	9	405 - 528	472	397 - 2098	1090
	River carpsucker	8	480 - 534	504	907 - 2325	1644
	Shorthead redhorse	5	350 - 428	397	438 - 872	668
	Sauger	4	277 - 484	352	148 - 764	344
	Freshwater drum	3	373 - 450	408	670 - 851	781
	Channel catfish	2	458 - 482	470	710 - 1021	866
	Northern pike	2	690 - 1010	850	1899 - 6877	4398
	Rainbow trout	1	551		1474	
	Creek chub	1	186		52	
	Total	203				

Source: Woodward-Envicon, Inc., Analysis, 1974.

NUMBER, LENGTH AND WEIGHT OF FISH COLLECTED WITH A 50-FOOT BAG SEINE IN RENNER BAY,

Month	Species	Number	Length (mm) Min-Max	Length (mm) $\bar{x}$	Weight (g) Min-Max	Weight (g) $\bar{x}$
May	Yellow perch	50	50 - 73	64.5	1.1 - 4.3	2.5
	Johnny darter	2	53 - 57	55.0	1.7 - 2.1	1.9
	Total	52				
June	Emerald shiner	65	26 - 92	70.4	0.3 - 8.9	3.8
	Yellow perch	25	22 - 90	70.0	0.1 - 9.0	4.3
	White sucker	3	104 - 122	22	11.9 - 19.0	15
	Carp	1	420		930	
	Northern redbelly dace	1	50		0.9	
	Total	95				
July	Yellow perch	1953[1]	27 - 108	36	0.1 - 16.4	0.7
	Carp	223	22 - 37	27	0.1 - 0.7	0.3
	Emerald shiner	118	48 - 103	78	0.9 - 10.4	3.0
	White sucker	101	27 - 39	30	0.1 - 0.7	0.5
	Sand shiner	3	29 - 65	50	0.1 - 2.8	1.6
	Johnny darter	3	23 - 29	26	0.2	0.2
	Goldeye	1	153		32.9	
	Flathead chub	1	125		24.8	
	Total	2403				
August	Emerald shiner	3434[2]	22 - 99	62	0.1 - 7.2	2.1
	Yellow perch	65	52 - 70	61	1.5 - 3.8	2.4
	White bass	57[3]	92 - 102	96	10.3 - 14.3	12.2
	White sucker	39	46 - 67	56	1.4 - 3.4	2.1
	Johnny darter	34	20 - 46	39	0.1 - 1.2	0.7
	Plains minnows	31	65 - 102	96	2.5 - 12.1	9.3
	Fathead minnow	3	32 - 57	48	0.3 - 2.1	1.5
	Carp	2	30 - 37	34	0.4 - 0.9	0.7
	Total	3665				
September	Emerald shiner	35	67 - 79	73	2.6 - 4.4	3.2
	Yellow perch	5	62 - 72	66	2.9 - 4.0	3.3
	Johnny darter	5	28 - 56	43	0.3 - 1.8	1.0
	Iowa darter	1	45		0.8	
	Total	46				
October	Emerald shiner	135	23 - 97	56	0.1 - 7.1	2.2
	Johnny darter	15	44 - 58	51	0.7 - 2.4	1.5
	Yellow perch	9	64 - 69	67	2.7 - 3.9	3.4
	Rainbow trout	1	134		29	
	White sucker	1	68		3.5	
	Flathead chub	1	71		3.5	
	Total	162				

[1] 350 were weighed and measured.

[2] 619 were weighed and measured.

[3] 6 were weighed and measured.

Source: Woodward-Envicon, Inc. Analysis, 1974.

MACROINVERTEBRATES COLLECTED FROM AQUATIC ECOSYSTEMS, MERCER COUNTY, NORTH DAKOTA,

Common Name	Scientific Name	Lake Sakakawea	Knife River Drainage	Ponds
Roundworms	Nematoda	X	X	
Horsehair worms	Nematomorpha		X	
Aquatic earthworms	Oligochaeta	X	X	
Leeches	Hirudinea		X	X
Sideswimmers	Hyalella azteca	X	X	X
	Gammarus sp.		X	
Crayfish	Orconectes sp.		X	
Stonefly nymphs	Perlesta sp.		X	
Mayfly nymphs	Hexagenia sp.	X	X	
	Ephoron sp.		X	
	Baetis sp.	X	X	
	Pseudocloeon sp.		X	
	Tricorythodes sp.		X	
	Caenis sp.	X	X	
	Isonychia sp.		X	
	Leptophlebiinae		X	
	Leptophlebia		X	
	Stenonema sp.		X	
	Heptagenia sp.		X	
Dragonfly nymphs	Gomphus sp.		X	
	Libellula sp.			X
Damselfly nymphs	Aeschna sp.		X	
	Agrion sp.		X	
	Enallagma sp.	X	X	X
Water boatmen	Corixidae		X	X
Water striders	Gerridae		X	X
Alderfly larvae	Sialis sp.		X	
Caddis fly larvae	Hydropsyche sp.		X	
	Cheumatopsyche sp.	X	X	
	Polycentropus sp.		X	
	Oecetis sp.	X	X	
	Athripsodes sp.		X	
	Leptocella sp.		X	
	Triaenodes sp.			X
	Limnephilus sp.		X	
	Pycnopsyche sp.		X	
	Astenophylx sp.		X	
	Ptilostomis sp.		X	
	Phryganea sp.			X
	Agrypnia sp.		X	
Riffle beetles	Elmidae		X	
Predaceous diving beetles	Dytiscidae			X
Crane fly larvae	Tipulidae		X	
Black fly larvae	Simulium sp.		X	
Midge larvae	Pentaneurini		X	
	Procladius sp.	X	X	
	Chironomus sp.	X	X	
	Dicrotendipes sp.	X	X	
	Cryptochironomus sp.	X	X	
	Paracladopelma sp.	X		
	Endochironomus sp.		X	
	Xenochironomus sp.		X	
	Glyptotendipes sp.		X	
	Polypedilum sp.	X	X	
	Paralauterborniella sp.		X	
	Paratendipes sp.	X	X	
	Strictochironomus sp.		X	
	Microtendipes sp.		X	
	Tanytarsus sp.	X	X	
	Diamesinae		X	
	Eukiefferiella sp.		X	
	Cricotopus sp.		X	
Biting midge larvae	Ceratopogonidae	X	X	
Soldier fly larvae	Odontomyia sp.			X
Horsefly larvae	Tabanidae		X	
Snails	Physa sp.		X	
	Lymnaea sp.		X	
Mussels	Unionidae		X	
	Sphaerium sp.		X	
Total		18	63	10

Source: Woodward-Envicon, Inc. Analysis, 1974.

NUMBER OF MACROINVERTEBRATES PER SQUARE METER AND PERCENT RELATIVE ABUNDANCE COLLECTED IN RENNER BAY,

Station 1

Organism	May		June		July		Aug.		Sept.		Oct.	
Nematoda	4.8[1]	0.7[2]	28.6	3.6	--	--	--	--	--	--	--	--
Oligochaeta	104.8	16.3	--	--	33.3	15.2	19.0	12.9	9.5	3.9	--	--
Hexagenia sp.	--	--	--	--	--	--	--	--	--	--	6.2	2.2
Cheumatopsyche sp.	--	--	--	--	--	--	--	--	--	--	--	--
Oecetis sp.	--	--	--	--	4.8	2.2	--	--	--	--	--	--
Chironomidae	533.3	82.9	766.8	96.4	180.9	82.6	128.7	87.0	233.3	96.1	281.2	97.8
Procladius sp.	323.8	50.4	14.3	1.8	52.4	23.9	81.0	54.8	223.8	92.2	281.2	97.8
Chironomus sp.	161.9	25.2	304.8	38.3	9.5	4.3	14.3	9.6	--	--	--	--
Dicrotendipes sp.	--	--	23.8	3.0	--	--	--	--	--	--	--	--
Cryptochironomus sp.	38.1	5.9	42.9	5.4	14.3	6.5	4.8	3.2	9.5	3.9	--	--
Paracladopelma sp.	--	--	--	--	--	--	--	--	--	--	--	--
Polypedilum sp.	--	--	166.7	46.1	85.7	39.1	--	--	--	--	--	--
Paratendipes sp.	--	--	4.8	0.6	--	--	--	--	--	--	--	--
Tanytarsus sp.	4.8	0.7	--	--	--	--	--	--	--	--	--	--
Genus A	--	--	--	--	9.5	4.3	28.6	19.4	--	--	--	--
Pupae	4.8	0.7	--	--	9.5	4.3	--	--	--	--	--	--
Ceratopogonidae	--	--	--	--	--	--	--	--	--	--	--	--
Total	643.0	99.9	795.4	100.0	219	100.0	147.7	99.9	242.8	100.0	287.4	100.0

Station 2

Organism	May		June		July		Aug.		Sept.		Oct.	
Nematoda	--	--	--	--	--	--	--	--	--	--	--	--
Oligochaeta	52.4	7.0	19.0	7.1	57.1	15.6	4.8	4.8	219.0	75.4	81.0	27.4
Hexagenia sp.	--	--	--	--	--	--	--	--	--	--	--	--
Cheumatopsyche sp.	--	--	--	--	--	--	4.8	4.8	--	--	--	--
Oecetis sp.	--	--	--	--	--	--	--	--	--	--	--	--
Chironomidae	695.4	93.0	247.6	92.9	309.6	84.4	90.6	90.4	71.3	24.5	214.3	72.6
Procladius sp.	681.0	91.1	209.5	78.6	300.0	81.8	66.7	66.6	38.0	13.1	181.0	61.3
Chironomus sp.	4.8	0.6	--	--	4.8	1.3	14.3	14.3	9.5	3.3	--	--
Dicrotendipes sp.	4.8	0.6	--	--	--	--	--	--	--	--	--	--
Cryptochironomus sp.	--	--	9.5	3.6	--	--	4.8	4.8	4.8	1.6	33.3	11.3
Paracladopelma sp.	--	--	19.0	7.1	--	--	4.8	4.8	19.0	6.5	--	--
Polypedilum sp.	--	--	4.8	1.8	--	--	--	--	--	--	--	--
Paratendipes sp.	--	--	--	--	--	--	--	--	--	--	--	--
Tanytarsus sp.	4.8	0.6	--	--	--	--	--	--	--	--	--	--
Genus A	--	--	--	--	4.8	1.3	--	--	--	--	--	--
Pupae	--	--	4.8	1.8	--	--	--	--	--	--	--	--
Ceratopogonidae	--	--	--	--	--	--	--	--	--	--	--	--
Total	747.8	99.9	266.6	100.0	366.7	100.0	100.2	100.1	290.5	99.9	295.3	100.0

Station 3

Organism	May		June		July		Aug.		Sept.		Oct.	
Nematoda	--	--	--	--	--	--	--	--	--	--	--	--
Oligochaeta	14.3	1.3	100.0	35.0	14.3	3.7	23.8	5.0	4.8	1.2	14.3	7.7
Hexagenia sp.	--	--	--	--	--	--	--	--	--	--	--	--
Caenis sp.	--	--	--	--	--	--	--	--	9.5	2.4	--	--
Cheumatopsyche sp.	--	--	--	--	--	--	--	--	--	--	--	--
Oecetis sp.	4.8	0.4	--	--	4.8	1.2	--	--	--	--	--	--
Chironomidae	1095.2	98.3	185.7	65.0	371.6	95.1	447.5	95.0	375.6	96.3	171.4	92.3
Procladius sp.	1042.8	93.6	138.1	48.3	304.8	78.0	119.0	25.2	209.0	53.6	23.8	12.8
Chironomus sp.	23.8	2.1	19.0	6.6	4.8	1.2	--	--	9.5	2.4	--	--
Dicrotendipes sp.	--	--	14.3	5.0	--	--	--	--	--	--	--	--
Cryptochironomus sp.	4.8	0.4	--	--	14.3	3.7	47.6	10.1	95.2	24.4	119.0	64.1
Paracladopelma sp.	--	--	14.3	5.0	4.8	1.2	--	--	23.8	6.1	--	--
Polypedilum sp.	--	--	--	--	14.3	3.7	261.9	55.6	33.3	8.5	14.3	7.7
Paratendipes sp.	--	--	--	--	--	--	--	--	--	--	--	--
Tanytarsus sp.	4.8	0.4	--	--	4.8	1.2	--	--	--	--	14.3	7.7
Genus A	19.0	1.7	--	--	23.8	6.1	9.5	2.0	--	--	--	--
Pupae	--	--	--	--	--	--	9.5	2.0	4.8	1.2	--	--
Ceratopogonidae	--	--	--	--	--	--	--	--	--	--	--	--
Total	1114.3	99.9	285.7	99.9	390.7	100.0	471.3	99.9	389.9	99.8	185.7	100.0

Station 4

Organism	May		June		July		Aug.		Sept.		Oct.	
Nematoda	--	--	--	--	--	--	--	--	--	--	--	--
Oligochaeta	233.3	34.7	142.9	31.3	157.1	15.3	42.9	8.0	23.8	22.7	109.5	50
Hexagenia sp.	--	--	--	--	--	--	--	--	--	--	--	--
Cheumatopsyche sp.	--	--	--	--	--	--	--	--	--	--	--	--
Oecetis sp.	--	--	--	--	--	--	--	--	--	--	--	--
Chironomidae	438.1	65.2	314.2	68.7	866.7	84.7	490.5	92.0	80.9	77.3	109.5	50
Procladius sp.	414.3	61.7	261.9	57.3	714.3	69.8	423.8	79.4	19.0	18.1	85.7	39.1
Chironomus sp.	14.3	2.1	--	--	42.9	4.2	4.8	1.0	--	--	--	--
Dicrotendipes sp.	--	--	23.8	5.2	--	--	--	--	--	-	--	--
Cryptochironomus sp.	9.5	1.4	--	--	9.5	0.9	38.1	7.1	4.8	4.6	19.0	8.7
Paracladopelma sp.	--	--	9.5	2.1	9.5	0.9	--	--	57.1	54.5	--	--
Polypedilum sp.	--	--	19.0	4.2	--	--	--	--	--	--	--	--
Paratendipes sp.	--	--	--	--	--	--	--	--	--	--	--	--
Tanytarsus sp.	--	--	--	--	--	--	--	--	--	--	4.8	2.2
Genus A	--	--	--	--	90.5	8.8	--	--	--	--	--	--
Pupae	--	--	--	--	--	--	23.8	4.5	--	--	--	--
Ceratopogonidae	--	--	--	--	--	--	--	--	--	--	--	--
Total	671.4	99.5	457.1	100.1	1023.8	99.9	533.4	100.0	104.7	99.9	219.0	100.0

Station 5

Organism	May[3]		June		July		Aug.		Sept.		Oct.	
Nematoda	--	--	--	--	--	--	--	--	--	--	--	--
Oligochaeta	--	--	14.3	4.6	90.5	16.2	33.3	36.8	19.0	13.8	133.3	40.6
Hexagenia sp.	--	--	--	--	--	--	--	--	--	--	--	--
Cheumatopsyche sp.	--	--	--	--	--	--	--	--	--	--	--	--
Oecetis sp.	--	--	--	--	--	--	---	--	--	--	--	--
Chironomidae	--	--	295.3	95.4	466.8	83.8	57.2	63.2	119.1	86.2	195.3	59.4
Procladius sp.	--	--	252.4	81.5	404.8	72.6	38.1	42.1	109.5	79.3	181.0	55.1
Chironomus sp.	--	--	4.8	1.6	4.8	0.9	4.8	5.3	--	--	4.8	1.5
Dicrotendipes sp.	--	--	19.0	6.1	--	--	--	--	--	--	--	--
Cryptochironomus sp.	--	--	--	--	4.8	0.9	9.5	10.5	4.8	3.5	9.5	2.9
Paracladopelma sp.	--	--	14.3	4.6	42.9	7.7	--	--	--	--	--	--
Polypedilum sp.	--	--	--	--	--	--	4.8	5.3	--	--	--	--
Paratendipes sp.	--	--	--	--	--	--	--	--	--	--	--	--
Tanytarsus sp.	--	--	--	--	--	--	--	--	--	--	--	--
Genus A	--	--	--	--	9.5	1.7	--	--	--	--	--	--
Pupae	--	--	4.8	1.6	--	--	--	--	--	--	--	--
Ceratopogonidae	--	--	--	--	--	--	--	--	4.8	3.5	--	--
Total	--	--	309.6	100.0	557.3	100.0	90.5	100.0	138.1	100.0	328.6	100.1

Station 6

Organism	May		June		July		Aug.		Sept.		Oct.	
Nematoda	--	--	--	--	--	--	--	--	--	--	9.5	22.2
Oligochaeta	400.0	46.6	204.8	48.3	57.1	29.2	114.3	50.0	19.0	21.0	--	--
Hexagenia sp.	--	--	--	--	--	--	--	--	--	--	--	--
Cheumatopsyche sp.	--	--	--	--	--	--	--	--	--	--	--	--
Oecetis sp.	--	--	--	--	--	--	4.8	4.8	--	--	--	--
Chironomidae	458.9	53.4	219.1	51.7	138.1	70.8	109.6	47.9	71.4	79.0	33.3	77.8
Procladius sp.	444.6	51.8	161.9	38.2	81.0	41.5	81.0	35.5	71.4	79.0	19.0	44.4
Chironomus sp.	9.5	1.1	4.8	1.1	9.5	4.9	--	--	--	--	9.5	22.2
Dicrotendipes sp.	--	--	14.3	3.4	--	--	--	--	--	--	--	--
Cryptochironomus sp.	--	--	33.3	7.9	9.5	4.9	--	--	--	--	--	--
Paracladopelma sp.	--	--	4.8	1.1	9.5	4.9	23.8	10.4	--	--	--	--
Polypedilum sp.	--	--	--	--	9.5	4.9	--	--	--	--	--	--
Paratendipes sp.	--	--	--	--	--	--	--	--	--	--	--	--
Tanytarsus sp.	--	--	--	--	4.8	2.5	--	--	--	--	4.8	11.2
Genus A	4.8	0.6	--	--	--	--	--	--	--	--	--	--
Pupae	--	--	--	--	4.8	2.5	4.8	2.1	--	--	--	--
Ceratopogonidae	--	--	--	--	--	--	--	--	--	--	--	--
Total	858.9	100.1	423.9	100.0	195.2	100.2	228.7	100.1	90.4	100.0	42.8	100.0

[1] Mean density number per square meter

[2] Percent relative numerical abundance

[3] Samples not taken

Source: Woodward-Envicon, Inc., Analysis, 1974.

ZOOPLANKTON MAJOR GROUP DENSITY[1] AND PERCENT ABUNDANCE[2] FROM LAKE SAKAKAWEA (RENNER BAY) FOR JULY - SEPTEMBER 1974

		Depth									
		1 Meter		8 Meters		15 Meters		30 Meters		Mean (4 Depths)	
Date	Major Group	Density	Percent	Density	Percent	Density	Percent	Density	Percent	Density	Percent
Early July	Cladocera	2.0	(10.2)	1.6	(9.0)	0.2	(0.7)	0.2	(0.7)	1.0	(4.3)
	Copepoda	16.5	(84.2)	14.9	(83.7)	25.3	(95.8)	28.2	(95.9)	21.2	(91.0)
	Rotifera	1.1	(5.6)	1.3	(7.3)	0.9	(3.5)	1.0	(3.4	1.1	(4.7)
	Total (all zooplankton)	19.6		17.8		26.4		29.4		23.3	
Late July	Cladocera	4.3	(13.0)	2.6	(10.1)	2.4	(9.6)	0.2	(0.6)	2.4	(8.2)
	Copepoda	24.0	(72.5)	18.6	(72.7)	20.1	(80.8)	31.9	(96.4)	23.6	(81.2)
	Rotifera	4.8	(14.5)	4.4	(17.2)	2.4	(9.6)	1.0	(3.0)	3.1	(10.6)
	Total	33.1		25.6		24.9		33.1		29.1	
Early August	Cladocera	8.8	(30.3)	1.0	(6.0)	0.8	(3.8)	0.9	(2.3)	2.9	(11.0)
	Copepoda	13.4	(46.6)	11.	(71.7)	18.9	(89.1)	36.0	(94.1)	20.1	(76.5)
	Rotifera	6.7	(23.1)	3.7	(22.3)	1.5	(7.1)	1.4	(3.6)	3.3	(12.5)
	Total	29.0		16.6		21.2		38.3		26.3	
Sept.	Cladocera	3.9	(16.4)	5.6	(25.0)	2.1	(17.2)	1.1	(14.1)	3.2	(19.3)
	Copepoda	13.6	(57.2)	12.9	(57.6)	7.5	(61.5)	5.6	(72.8)	9.9	(59.6)
	Rotifera	6.3	(26.4)	3.9	(17.4)	2.6	(21.3)	1.1	(14.1)	3.5	(21.1)
	Total	23.8		22.4		12.2		7.8		16.6	

[1]Density units: organisms per liter (liter^{-1}).

[2]Percent of total zooplankton density.

Source: Woodward-Envicon, Inc., Analysis, 1974.

ZOOPLANKTON DENSITY[1] AND PERCENT ABUNDANCE[2] (PREDOMINANT TAXA) FROM LAKE SAKAKAWEA (RENNER BAY) FOR JULY - SEPTEMBER 1974 AT 4 DEPTHS

		Depth									
		1 Meter		8 Meters		15 Meters		30 Meters		Mean (4 Depths)	
Date	Taxa	Density	Percent	Density	Percent	Density	Percent	Density	Percent	Density	Percent
Early July	Daphnia	1.9	(9.7)	1.6	(9.0)	0.2	(0.7)	0.1	(0.3)	0.9	(3.9)
	Nauplii	8.9	(45.4)	8.2	(46.1)	17.0	(64.3)	19.4	(66.0)	13.4	(57.5)
	Cyclopoida	3.3	(16.8)	4.0	(22.5)	6.9	(26.1)	8.5	(28.9)	5.7	(24.5)
	Diaptomus	4.1	(20.9)	2.7	(15.1)	1.3	(4.9)	0.4	(1.4)	2.1	(9.0)
	Polyarthra	0.8	(4.0)	0.8	(4.5)	0.4	(1.5)	0.3	(1.0)	0.6	(2.5)
	Total (all zooplankton)	19.6		17.8		26.4		29.4		23.3	
Late July	Daphnia	4.3	(13.0)	2.6	(10.1)	1.9	(7.6)	0.1	(0.3)	2.2	(7.5)
	Nauplii	9.3	(28.1)	7.6	(29.7)	7.8	(31.3)	19.6	(59.2)	11.1	(38.0)
	Cyclopoida	9.9	(29.9)	7.7	(30.0)	9.2	(36.9)	11.3	(34.1)	9.5	(32.5)
	Diaptomus	4.6	(13.9)	3.2	(12.5)	2.5	(10.0)	0.7	(2.1)	2.7	(9.2)
	Polyarthra	4.2	(12.7)	3.8	(14.8)	2.1	(8.4)	0.4	(1.2)	2.6	(8.9)
	Total	33.1		25.6		24.9		33.1		29.2	
Early August	Daphnia	8.7	(30.0)	1.0	(6.0)	0.8	(1.8)	0.9	(2.3)	2.8	(10.6)
	Nauplii	4.9	(16.9)	6.9	(41.6)	11.7	(55.2)	23.0	(60.0)	11.6	(44.1)
	Cyclopoida	6.8	(23.4)	3.9	(23.5)	5.5	(25.9)	12.1	(31.6)	7.1	(27.0)
	Diaptomus	1.8	(6.3)	1.1	(6.6)	1.5	(7.1)	1.1	(2.9)	1.4	(5.3)
	Polyarthra	6.4	(22.1)	3.6	(21.7)	1.2	(5.7)	0.9	(2.3)	3.0	(11.4)
	Total	29.0		16.5		21.2		38.3		26.3	
Sept.	Daphnia	3.7	(15.5)	5.4	(24.1)	1.8	(14.7)	0.9	(11.5)	3.0	(18.1)
	Nauplii	4.0	(16.8)	5.4	(24.1)	3.6	(29.5)	2.5	(32.1)	3.9	(23.5)
	Cyclopoida	6.0	(25.2)	5.2	(23.2)	3.2	(26.2)	2.6	(33.3)	4.2	(25.3)
	Diaptomus	3.8	(16.0)	2.2	(9.8)	0.8	(6.5)	0.4	(5.1)	1.8	(10.8)
	Polyarthra	6.1	(25.6)	3.9	(17.4)	2.6	(21.3)	0.9	(11.5)	3.4	(20.5)
	Total	23.8		22.4		12.2		7.8		16.6	

[1]Density units: organisms per liter (liter^{-1}).

[2]Percent of total zooplankton density.

Source: Woodward-Envicon, Inc., Analysis, 1974.

PHYTOPLANKTON DENSITY[1] AND PERCENT ABUNDANCE[2] FROM LAKE SAKAKAWEA (RENNER BAY) FOR JUNE - SEPTEMBER, 1974

Date	Major Group	Depth: 1 Meter Density	1 Meter Percent	8 Meters Density	8 Meters Percent	15 Meters Density	15 Meters Percent	30 Meters Density	30 Meters Percent	Mean (4 Depths) Density	Mean (4 Depths) Percent
Late June	Centrales	30.2	(12.6)	33.1	(12.0)	39.1	(16.0)	38.4	(18.9)	35.8	(14.6)
	Pennales	203.0	(85.0)	242.9	(87.8)	200.5	(81.9)	162.9	(80.2)	203.1	(84.0)
	Other Phyto.	5.7	(2.4)	0.7	(0.2)	5.2	(2.1)	1.8	(.0.9)	3.3	(1.4)
	Total (all phytoplankton)	238.9		276.7		244.8		203.1		240.8	
Early July	Centrales	3.5	(9.8)	5.9	(8.8)	11.3	(11.1)	20.7	(22.8)	10.4	(14.1)
	Pennales	31.1	(87.1)	60.1	(89.7)	88.0	(86.3)	70.0	(77.1)	62.3	(84.3)
	Other Phyto.	1.1	(3.1)	1.0	(1.5)	2.7	(2.6)	0.1	(0.1)	1.2	(1.6)
	Total	35.7		67.0		102.0		90.8		73.9	
Late July	Centrales	4.1	(11.6)	5.0	(9.3)	10.8	(7.1)	5.5	(14.6)	6.4	(9.2)
	Pennales	31.0	(87.6)	48.4	(90.5)	140.0	(92.4)	32.3	(85.4)	62.9	(90.4)
	Other Phyto.	0.3	(0.8)	0.1	(0.2)	0.7	(0.5)	—	—	0.3	(0.4)
	Total	35.4		53.5		151.5		37.8		69.6	
Early August	Centrales	0.6	(3.6)	1.5	(9.7)	5.5	(11.6)	4.8	(11.0)	3.1	(10.1)
	Pennales	15.1	(89.9)	12.5	(80.6)	40.9	(86.1)	38.4	(88.3)	26.7	(86.7)
	Other Phyto.	1.1	(6.5)	1.5	(9.7)	1.1	(2.3)	0.1	(0.7)	1.0	(3.2)
	Total	16.8		15.5		47.4		43.5		30.8	
Late August	Centrales	1.0	(12.8)	1.6	(11.3)	2.7	(7.9)	4.8	(10.6)	2.5	(9.8)
	Pennales	6.2	(79.5)	12.0	(84.5)	31.0	(90.4)	40.5	(89.4)	22.4	(88.2)
	Other Phyto.	0.6	(7.7)	0.6	(4.2)	0.6	(1.7)	—	—	0.5	(2.0)
	Total	7.8		14.2		34.3		45.3		25.4	
Sept.	Centrales	1.6	(8.2)	2.5	(14.3)	2.6	(15.2)	1.1	(9.5)	2.4	(11.1)
	Pennales	16.2	(83.6)	14.4	(82.3)	14.0	(81.9)	29.4	(89.9)	18.5	(85.7)
	Other Phyto.	1.6	(8.2)	0.6	(3.4)	0.5	(2.9)	0.2	(0.6)	0.7	(3.2)
	Total	19.4		17.5		17.1		32.7		21.6	

[1]Density units: cells per milliliter (ml^{-1}).

[2]Percent total of total phytoplankton density.

Source: Woodward-Envicon, Inc., Analysis, 1974.

PHYTOPLANKTON DENSITY[1] AND PERCENT ABUNDANCE[2] (PREDOMINANT TAXA) FROM LAKE SAKAKAWEA (RENNER BAY) FOR JUNE - SEPTEMBER 1974

Date	Taxa	Depth: 1 Meter Density	1 Meter Percent	8 Meters Density	8 Meters Percent	15 Meters Density	15 Meters Percent	30 Meters Density	30 Meters Percent	Mean (4 Depths) Density	Mean (4 Depths) Percent
Late June	Melosira italica	29.3	(12.3)	32.0	(11.6)	37.0	(15.1)	35.8	(17.6)	33.5	(13.9)
	Asterionella formosa	75.7	(31.7)	62.0	(22.4)	64.0	(26.1)	40.8	(20.1)	60.6	(25.1)
	Fragilaria crotonensis	107.0	(44.8)	158.5	(57.3)	109.0	(44.5)	77.4	(38.1)	113.0	(46.9)
	Fragilaria virescens	8.2	(3.4)	13.1	(4.7)	8.2	(3.3)	23.4	(11.5)	13.2	(5.5)
	Total (all phytoplankton)	238.9		276.7		244.8		203.1		240.9	
Early July	Melosira italica	1.3	(3.7)	3.5	(5.5)	8.3	(8.3)	18.7	(20.6)	7.9	(10.9)
	Asterionella formosa	7.7	(21.2)	7.5	(11.8)	8.0	(8.0)	10.1	(11.1)	8.3	(11.5)
	Fragilaria crotonensis	10.7	(30.8)	12.5	(19.7)	22.0	(22.0)	36.3	(40.0)	20.4	(28.2)
	Fragilaria virescens	4.4	(12.7)	15.0	(23.6)	12.0	(12.0)	8.6	(9.5)	10.0	(13.8)
	Navicula capitata	1.3	(3.7)	5.5	(8.7)	12.3	(12.3)	1.5	(1.7)	5.2	(7.2)
	Nitzschia recta	0.8	(2.3)	4.0	(6.3)	8.7	(8.7)	3.4	(3.7)	4.2	(5.8)
	Total	34.7		63.5		100.0		90.6		72.3	
Late July	Melosira italica	2.7	(7.6)	3.0	(5.6)	6.7	(4.4)	3.9	(10.3)	4.1	(5.9)
	Asterionella formosa	5.3	(14.8)	8.5	(15.9)	13.0	(8.6)	6.7	(17.7)	8.4	(12.1)
	Fragilaria crotonensis	8.0	(22.4)	5.5	(10.3)	23.7	(15.6)	3.7	(9.8)	10.2	(14.6)
	Fragilaria virescens	3.0	(8.4)	8.5	(15.9)	20.0	(13.2)	6.6	(17.5)	9.5	(13.6)
	Navicula capita	4.7	(13.2)	7.0	(13.1)	22.7	(15.0)	3.1	(8.2)	9.4	(13.5)
	Nitzschia recta	2.7	(7.6)	4.5	(8.4)	13.0	(8.6)	3.3	(8.7)	5.9	(8.5)
	Total	35.7		53.5		151.7		37.8		69.7	
Early August	Melosira italica	0.3	(2.2)	1.1	(7.1)	3.2	(6.7)	2.1	(5.5)	1.7	(5.9)
	Achnanthes	1.6	(11.7)	0.3	(1.9)	2.0	(4.2)	1.7	(4.4)	1.4	(4.8)
	Asterionella formosa	1.1	(8.0)	3.3	(21.3)	2.2	(4.6)	10.9	(28.4)	4.4	(15.2)
	Fragilaria crotonensis	0.4	(2.9)	2.5	(16.1)	2.3	(4.8)	3.5	(9.1)	2.2	(7.6)
	Fragilaria virescens	5.5	(40.1)	2.0	(12.9)	14.0	(29.2)	5.0	(13.0)	6.6	(22.8)
	Navicula capitata	1.4	(10.2)	1.3	(8.4)	8.0	(16.7)	5.5	(14.3)	4.1	(14.2)
	Nitzschia recta	0.6	(4.4)	0.5	(3.2)	2.4	(5.0)	2.7	(7.0)	1.6	(5.5)
	Total	11.7		15.5		48.0		38.4		28.9	
Late August	Melosira italica	0.3	(2.5)	0.2	(1.4)	0.8	(2.5)	1.4	(2.9)	0.7	(2.7)
	Achnanthes	0.4	(5.0)	0.6	(4.1)	2.2	(6.9)	1.6	(3.3)	1.2	(4.6)
	Asterionella formosa	0.4	(5.0)	1.1	(7.6)	0.3	(0.9)	5.4	(11.1)	1.8	(7.0)
	Fragilaria crotonensis	0.2	(2.5)	1.1	(7.6)	1.5	(4.7)	2.8	(5.8)	1.4	(5.4)
	Fragilaria virescens	1.9	(23.8)	2.7	(18.6)	5.7	(17.8)	4.3	(8.8)	3.7	(14.3)
	Navicula capitata	1.2	(15.0)	2.3	(15.9)	6.3	(19.7)	6.4	(13.2)	4.1	(15.9)
	Nitzschia recta	0.4	(5.0)	1.1	(7.6)	3.7	(11.6)	4.1	(8.6)	2.4	(9.3)
	Stephanodiscus	0.6	(7.5)	1.2	(8.3)	1.5	(4.7)	6.0	(12.3)	2.3	(8.9)
	Total	8.0		14.5		32.0		48.6		25.8	
Sept.	Melosira italica	0.5	(2.6)	0.4	(2.3)	0.4	(2.3)	0.8	(2.4)	0.5	(2.3)
	Achnanthes	1.3	(6.7)	0.4	(2.3)	0.7	(4.0)	2.0	(6.1)	1.1	(5.0)
	Asterionella formosa	3.9	(15.0)	0.6	(3.4)	2.0	(11.7)	3.4	(10.3)	2.3	(10.1)
	Fragilaria crotonensis	0.4	(2.1)	0.2	(1.1)	1.5	(8.7)	0.9	(2.7)	0.8	(3.7)
	Fragilaria virescens	2.7	(14.0)	1.7	(9.7)	2.3	(13.3)	6.2	(18.8)	4.3	(19.7)
	Navicula capitata	4.0	(20.7)	5.8	(33.1)	2.6	(15.0)	5.4	(16.4)	4.5	(20.6)
	Nitzschia recta	0.5	(2.6)	1.6	(9.1)	0.9	(5.2)	2.3	(7.0)	1.3	(6.0)
	Cymbella	0.7	(3.6)	0.8	(4.6)	0.6	(3.5)	1.0	(3.0)	0.8	(3.7)
	Stephanodiscus	0.8	(4.1)	1.9	(10.8)	1.8	(10.4)	2.0	(6.1)	1.4	(6.4)
	Total	19.3		17.5		17.3		33.0		21.8	

[1]Density units: cells per milliliter (ml^{-1})

[2]Percent of total phytoplankton density.

Source: Woodward-Envicon, Inc., Analysis, 1974.

NUMBER, LENGTH AND WEIGHT OF FISH COLLECTED IN THE KNIFE RIVER DRAINAGE

SPRING CREEK STATION 1

Month	Species	Number	Length (mm) Min-Max	Length (mm) X	Weight (g) Min-Max	Weight (g) X
May	White sucker	4	99 - 258	170.8	10 - 102	47.9
	Carp	2	465 - 520	492.5	1465 - 1500	982.5
	Iowa darter	2	47 - 50	48.5	1.0 - 1.5	1.2
	Walleye	1	272		160	
	Northern redbelly dace	1	58		1.7	
	Total	10				
June	Shorthead redhorse	5	262 - 394	300.6	164 - 562	264.4
	Sand shiner	3	40 - 46	44.0	0.7 - 1.1	0.9
	White sucker	2	282 - 409	343.0	232 - 734	367.0
	Carp	1	495		1474	
	Creek chub	1	70		3.4	
	Iowa darter	1	29		0.2	
	Total	13				
July	White sucker	107	38 - 218	49.2	0.6 - 129	4.4
	Sand shiner	29	40 - 60	51.4	0.5 - 2.3	1.4
	Carp	20	24 - 36	20.8	0.1 - 0.8	0.4
	Blacknose dace	3	29 - 33	30.3	0.1 - 0.2	0.1
	Shorthead redhorse	1	155		40.5	
	Northern pike	1	637		1588	
	Total	161				
August	Sand shiner	159	23 - 65	48.8	0.2 - 3.0	1.5
	White sucker	72	40 - 156	68.0	0.9 - 46.0	3.6
	Shorthead redhorse	8	38 - 48	43.0	0.7 - 1.5	1.0
	Carp	3	62 - 480	155.2	3.7 - 1474	375.6
	Northern pike	2	448 - 574	511	910 - 1229	1070
	Walleye	1	258		152	
	Iowa darter	1	28		0.2	
	Northern redbelly dace	1	56		1.9	
	Total	244				
September	Sand Shiner	236	25 - 70	46.4	0.1 - 3.6	1.3
	White sucker	14	70 - 100	82.7	3.9 - 10.8	6.6
	Shorthead redhorse	13	46 - 305	96.2	1.4 - 252.0	35.9
	Carp	6	52 - 121	93.2	2.8 - 30.0	17.1
	Blacknose dace	5	45 - 57	50.4	0.9 - 2.1	1.4
	Northern pike	1	384		324	
	Iowa darter	1	31		0.3	
	Total	276				
October	Sand shiner	184	35 - 64	42.0	0.4 - 2.7	0.8
	White sucker	4	93 - 197	137	8.5 - 95.4	41.6
	Fathead minnow	2	34 - 40	37.0	0.4 - 0.7	0.6
	Shorthead redhorse	1	195		89.9	
	Iowa darter	1	37		0.4	
	Total	192				

KNIFE RIVER STATION 2

Month	Species	Number	Length (mm) Min-Max	Length (mm) X	Weight (g) Min-Max	Weight (g) X
May	Sand shiner	226	23 - 68	38.7	0.1 - 3.2	0.8
	Flathead chub	16	86 - 155	116.9	6.2 - 39.2	17.6
	White sucker	11	82 - 129	96.0	3.2 - 23.6	13.6
	Fathead minnow	9	31 - 43	37.5	0.4 - 1.1	0.7
	Blacknose dace	7	37 - 50	44.1	0.5 - 1.3	0.9
	River carpsucker	3	46 - 60	55.0	1.1 - 2.3	1.9
	Shorthead redhorse	3	116 - 269	171.6	17.8 - 220	87.2
	Stonecat	1	44 - 49	47.3	1.0 - 1.6	1.4
	Total	278				
June	Sand shiner	120	25 - 65	38.4	0.2 - 2.8	0.7
	Flathead chub	8	63 - 119	104.3	2.5 - 17.5	12.5
	White sucker	5	89 - 134	105.4	7.8 - 25.4	13.1
	Shorthead redhorse	4	72 - 305	162.8	4.0 - 258	79.8
	Fathead minnow	3	35 - 37	36.0	0.8 - 0.7	0.6
	Blacknose dace	1	55		2.0	
	Creek chub	1	130		22.2	
	Walleye	1	174		66	
	Iowa darter	1	55		1.7	
	Total	144				
July	Sand shiner	87	26 - 53	39.4	0.2 - 1.6	0.7
	Flathead chub	7	114 - 163	133.1	14.4 - 44.5	23.6
	Blacknose dace	5	29 - 70	39.0	0.3 - 4.5	1.2
	Shorthead redhorse	4	60 - 268	164.0	2.5 - 178.0	66.1
	White sucker	3	105 - 134	124.0	12.5 - 26.3	21.2
	Walleye	2	200 - 226	213.0	78.0 - 110.0	94.0
	Iowa darter	2	33 - 46	39.5	0.4 - 1.3	0.8
	Goldeye	1	55		1.3	
	Northern redbelly dace	1	63		3.3	
	Total	112				
August	Sand shiner	179	25 - 63	44.9	0.1 - 2.8	1.0
	White sucker	40	54 - 158	82.4	1.7 - 46.2	8.6
	Shorthead redhorse	13	33 - 117	56.6	0.6 - 17.4	3.5
	Carp	9	45 - 75	55.7	1.6 - 6.8	3.0
	Flathead chub	6	110 - 160	142.5	12.2 - 38.6	28.5
	Creek chub	5	46 - 52	49.0	1.1 - 1.6	1.3
	Lake chub	3	26 - 35	31.3	0.2 - 0.6	0.4
	Fathead minnow	2	39 - 40	39.5	0.5 - 0.6	0.6
	Stonecat	2	104 - 105	104.5	13.4 - 14.2	13.8
	Iowa darter	1	31		0.3	
	Total	260				

(continues)

Month	Species	Number	Length (mm) Min-Max	Length (mm) $\bar{x}$	Weight (g) Min-Max	Weight (g) $\bar{x}$
September	Sand shiner	268	21 - 70	42.9	0.1 - 2.9	0.9
	Shorthead redhorse	21	40 - 120	64.5	0.7 - 18.9	4.8
	White sucker	9	60 - 172	133.3	2.3 - 55.2	31.3
	Creek chub	5	56 - 62	58.0	1.9 - 2.5	2.1
	Carp	5	60 - 70	65.8	3.8 - 5.6	4.9
	Flathead chub	3	53 - 119	89.0	1.7 - 16.7	9.0
	Fathead minnow	2	41	41	0.6	0.6
	Blacknose dace	1	75		5.2	
	River carpsucker	1	67		4.0	
	Total	315				
October	Sand shiner	60	30 - 62	46.8	1.1 - 3.3	2.0
	Fathead minnow	57	32 - 61	46.3	0.4 - 2.6	1.2
	Flathead chub	36	42 - 162	95.1	0.6 - 40.0	14.8
	Creek chub	19	54 - 122	64.5	1.6 - 18.0	3.5
	White sucker	11	74 - 191	127.4	4.5 - 64.0	27.0
	Carp	7	55 - 71	64.7	4.0 - 6.9	5.4
	River carpsucker	6	55 - 147	79.0	3.1 - 47.0	11.3
	Blacknose dace	2	38 - 45	41.5	0.6 - 0.9	0.8
	Total	198				
	SPRING CREEK STATION 3					
May	Shorthead redhorse	4	136 - 287	211.2	24.7 - 225.0	123.2
	White sucker	3	186 - 335	237.0	78 - 398	237.0
	Carp	2	435 - 520	477.5	1300 - 2000	1650
	Stonecat	2	125 - 141	133.0	20.7 - 38.3	29.5
	Blacknose dace	2	49 - 58	53.5	1.1 - 1.2	1.2
	Sand shiner	2	59 - 90	74.5	1.8 - 7.5	4.6
	Fathead minnow	1	67		3.4	
	Total	16				
June	Sand shiner	6	28 - 47	37.0	0.3 - 1.0	0.6
	White sucker	5	65 - 358	161.8	3.0 - 396	103.7
	Shorthead redhorse	4	145 - 340	274.2	29.0 - 356	224.8
	Iowa darter	2	41 - 49	45.0	0.8 - 1.3	1.0
	Flathead chub	1	175		56	
	Northern redbelly dace	1	59		1.4	
	Total	19				
July	White sucker	59	29 - 40	33.3	0.2 - 0.8	0.4
	Sand shiner	19	34 - 46	42.9	0.6 - 1.3	0.8
	Shorthead redhorse	5	261 - 419	332.4	148 - 736	363.6
	Blacknose dace	3	33 - 50	39.0	0.4 - 1.6	0.8
	Carp	2	39 - 40	39.5	1.3	1.3
	Northern pike	1	271		94	
	Northern redbelly dace	1	46		1.2	
	Total	90				
August	Sand shiner	128	30 - 60	48.0	0.3 - 2.2	1.2
	White sucker	122	22 - 166	58.1	0.2 - 59.6	3.3
	Carp	39	29 - 85	53.3	0.4 - 11.8	3.0
	Blacknose dace	23	28 - 112	50.1	0.2 - 16.1	2.2
	Stonecat	5	30 - 144	97.2	0.2 - 36.7	19.7
	Fathead minnow	1	35		0.6	
	Flathead chub	1	150		35.7	
	Brassy minnow	1	64		2.6	
	Iowa darter	1	43		0.7	
		321				
September	Sand shiner	291	27 - 63	44.5	0.2 - 2.4	0.9
	White sucker	60	55 - 146	69.6	2.2 - 34.1	4.4
	Shorthead redhorse	45	36 - 140	46.4	0.6 - 30.4	1.7
	Carp	41	35 - 79	55.8	0.7 - 9.3	3.6
	Blacknose dace	33	34 - 85	42.6	0.2 - 6.3	1.0
	Fathead minnow	10	43 - 51	47.4	0.9 - 1.6	1.1
	Flathead chub	6	130 - 180	157.2	21.0 - 60.0	39.6
	Stonecat	2	30 - 165	97.5	0.3 - 52.0	26.1
	Northern redbelly dace	2	38 - 43	40.5	0.5 - 0.9	0.7
	Total	490				
October	Sand shiner	156	27 - 63	40.0	0.1 - 2.6	0.6
	Fathead minnow	12	34 - 65	42.8	0.4 - 3.2	1.0
	White sucker	9	55 - 232	98.2	1.8 - 146.0	11.2
	Blacknose dace	8	35 - 75	49.1	0.5 - 4.6	1.7
	Shorthead redhorse	6	41 - 50	44.8	0.9 - 1.5	1.2
	Carp	2	40 - 55	47.5	1.2 - 3.1	2.2
	Northern pike	1	322		218	
	Stonecat	1	30		0.5	
	Iowa darter	1	54		1.6	
	Total	196				
	KNIFE RIVER STATION 4					
May	Sand shiner	23	36 - 72	46.9	0.3 - 3.3	1.0
	Blacknose dace	5	45 - 68	59.2	0.9 - 2.9	2.2
	Flathead chub	3	97 - 159	124.3	8.6 - 38.3	20.6
	White sucker	1	78		5.2	
	Shorthead redhorse	1	275		211.6	
	Total	33				
June	Sand shiner	64	30 - 64	43.9	0.3 - 2.4	0.9
	Blacknose dace	4	48 - 76	58.3	1.1 - 5.0	2.4
	Flathead chub	4	83 - 173	113.8	5.5 - 44.3	17.8
	Shorthead redhorse	4	61 - 176	98.8	2.6 - 58.7	17.7
	Emerald shiner	1	76		3.3	
	Total	77				

(continues)

Month	Species	Number	Length (mm) Min-Max	Length (mm) $\bar{x}$	Weight (g) Min-Max	Weight (g) $\bar{x}$
July	Sand shiner	374	17 - 65	43.7	Tr[2] - 3.4	1.0
	Fathead minnow	38	39 - 51	44.8	0.5 - 1.5	1.0
	White sucker	16	20 - 205	54.0	0.3 - 98.3	9.7
	Stonecat	3	75 - 165	108.3	8.0 - 36.6	16.4
	Blacknose dace	2	72 - 74	73.0	4.6	4.6
	Carp	1	420		902	
	Total	434				
August	Sand shiner	340	28 - 67	50.2	0.1 - 2.6	1.4
	Shorthead redhorse	23	35 - 284	76.2	0.4 - 174	14.2
	Carp	23	41 - 468	72.2	1.4 - 1077	49.3
	Fathead minnow	18	30 - 54	45.6	0.5 - 2.0	1.3
	Flathead chub	13	50 - 158	121.3	1.4 - 34.2	20.4
	Channel catfish	12	31 - 55	43.2	0.2 - 1.4	0.7
	Creek chub	4	51 - 95	63.5	1.4 - 8.9	3.4
	White sucker	4	51 - 54	53.0	1.4 - 1.7	1.5
	Blacknose dace	2	31 - 42	36.5	0.4 - 0.8	0.6
	Stonecat	1	84		6.5	
	Sauger	1	390		384	
	Total	441				
September	Sand shiner	434	25 - 57	38.4	0.1 - 2.0	0.6
	Fathead minnow	57	29 - 65	39.5	0.2 - 3.2	0.7
	Shorthead redhorse	16	43 - 215	75.9	1.0 - 98.1	10.3
	Flathead chub	7	130 - 177	155.6	20.2 - 55.8	32.6
	Channel catfish	6	45 - 49	46.5	1.0 - 1.2	1.1
	White sucker	6	75 - 230	169.5	5.1 - 298	81.3
	Blacknose dace	5	37 - 46	41.6	0.7 - 1.1	0.8
	Creek chub	3	53 - 75	60.6	1.3 - 4.3	2.4
	Carp	3	58 - 65	62.3	3.1 - 4.6	3.8
	River carpsucker	1	34		0.3	
	Total	538				
October	Sand shiner	450	26 - 65	41.0	0.1 - 3.0	0.9
	Fathead minnow	168[3]	32 - 62	38.4	0.4 - 2.7	0.9
	Flathead chub	21	67 - 175	139.9	3.6 - 56.0	30.3
	Shorthead redhorse	13	45 - 274	95.1	1.1 - 180.0	22.4
	Carp	6	50 - 71	63.3	2.3 - 6.3	4.7
	White sucker	3	65 - 120	91.7	3.3 - 20.0	10.3
	Creek chub	1	68		3.7	
	River carpsucker	1	51		1.8	
		663				
	KNIFE RIVER STATION 6					
May	Sand shiner	22	28 - 65	42.1	0.2 - 2.4	0.8
	White sucker	7	70 - 108	82.7	3.5 - 11.4	6.4
	Flathead chub	2	123 - 126	124.5	19.6 - 23.1	21.3
	Total	31				
June	Sand shiner	76	24 - 69	40.4	0.2 - 3.5	0.8
	Shorthead redhorse	14	63 - 92	71.4	2.8 - 8.0	4.1
	White sucker	6	87 - 117	104.8	5.6 - 14.8	10.6
	Fathead minnow	2	54 - 55	54.5	1.6 - 1.9	1.8
	Flathead chub	2	112 - 114	128.0	16.4 - 29.4	22.9
	Total	101				
July	Sand shiner	16	24 - 54	38.7	0.1 - 1.6	0.8
	Carp	13	25 - 34	27.4	0.2 - 0.5	0.4
	White sucker	9	23 - 130	41.7	0.2 - 24.0	3.0
	Fathead minnow	5	36 - 47	43.4	0.6 - 1.4	1.0
	Blacknose dace	3	34 - 39	37.0	0.4 - 0.8	0.6
	Total	46				
August	Sand shiner	70	27 - 60	33.4	0.2 - 2.3	0.4
	Shorthead redhorse	16	40 - 135	57.8	0.7 - 27.2	4.5
	Fathead minnow	6	25 - 38	30.3	0.1 - 0.7	0.3
	Channel catfish	4	41 - 50	45.3	0.7 - 1.1	1.0
	White sucker	2	125 - 134	129.5	22.0 - 27.7	24.8
	Carp	1	31		0.4	
	Creek chub	1	46		1.2	
	Sauger	1	305		162	
	Walleye	1	283		138	
	Total	102				
September	Sand shiner	246	21 - 62	37.1	Tr[1] - 2.3	0.6
	Shorthead redhorse	40	41 - 137	53.7	0.8 - 27.9	2.4
	Fathead minnow	20	23 - 33	23.8	0.1 - 0.4	0.2
	Creek chub	8	50 - 66	57.9	1.6 - 3.3	2.2
	Carp	7	40 - 70	52.3	1.4 - 5.9	2.8
	Channel catfish	6	35 - 48	46.2	0.5 - 1.3	1.2
	White sucker	2	61 - 66	63.5	2.9 - 3.6	3.2
	Walleye	1	325		238	
	Total	330				
October	Sand shiner	278	34 - 63	42.1	0.2 - 3.7	0.8
	Fathead minnow	17	32 - 45	39.2	0.5 - 1.1	0.7
	Creek chub	1	63		2.9	
	River carpsucker	1	36		0.6	
	White sucker	1	204		84	
	Shorthead redhorse	1	126		18	
	Total	299				

[1] 40 were weighed and measured.

[2] Trace.

[3] 44 were weighed and measured.

Source: Woodward-Envicon, Inc., Analysis, 1974.

NUMBER OF MACROINVERTEBRATES PER SQUARE METER AND PERCENT RELATIVE ABUNDANCE COLLECTED IN THE KNIFE RIVER DRAINAGE,

Spring Creek Station 1

Organism	May Number Per M²	May % of Total	June Number Per M²	June % of Total	July Number Per M²	July % of Total	August Number Per M²	August % of Total	September Number Per M²	September % of Total	October Number Per M²	October % of Total	Avg. No. Per Sample
Nematoda	33.3	9.1			7.4	1.2		0.8	3.7	0.3	12.5	1.4	10.1
Oligochaeta	85.2	23.2	37.0	40.0	37.0	6.2	29.6	6.1	66.7	5.9	85.2	9.4	56.8
Hyaliela azteca					7.4	1.2					7.4	0.8	2.5
Ephoron sp.					25.9	4.4							4.3
Baetis sp.			3.7	4.0	40.7	6.9	11.1	2.3	118.5	10.6	7.4	0.8	30.2
Caenis sp.	3.7	1.0	3.7	4.0	59.3	10.0							11.1
Isonychia sp.					3.7	0.6							0.6
Leptophlebia sp.											51.8	5.7	8.6
Stenonema sp.			7.4	8.0					3.7	0.3	270.4	30.0	46.9
Gomphus sp.					3.7	0.6			14.8	1.3			3.1
Corixidae (A)[1]	3.7	1.0			18.5	3.1	33.3	6.9	25.9	2.3	3.7	0.4	14.2
Sialis sp.							7.4	1.5			3.7	0.4	1.8
Hydropsyche sp.					7.4	1.2	7.4	1.5	66.7	5.9	70.4	7.8	25.3
Chesmatopsyche sp.					285.2	48.1	44.4	9.2	340.7	21.4	100.0	11.2	128.4
Polycentropus sp.							11.1	2.3					1.8
Leptocella sp.					7.4	1.2							1.2
Elmidae (L)[2]	11.1	3.0			7.4	1.2			37.0	3.3	3.7	0.4	9.9
Tipulidae											66.6	7.4	11.1
Simulium sp. (L)			18.5	20.0			3.7	0.8	229.6	20.5	56.2	6.2	51.3
Simulium sp. (P)[3]									3.7	0.3			0.6
Pentaneurini					25.9	4.4	3.7	0.8					4.9
Procladius sp.			7.4	8.0									1.2
Chironomus sp.	3.7	1.0							11.1	1.0			2.5
Cryptochironomus sp.	22.2	6.0	3.7	4.0	18.5	3.1	81.5	16.8	111.1	9.9	3.7	0.4	40.1
Polypedilum sp.	44.4	12.1			14.8	2.5	29.6	6.1	25.9	2.3			19.1
Strictochironomus sp.							7.4	1.5					1.2
Microtendipes sp.	7.4	2.0			3.7	0.6					10.4	1.2	3.6
Tanytarsus sp.	11.1	3.0	3.7	4.0			166.7	34.4	100.0	8.9			46.9
Chironomidae (P)	140.7	38.4			18.5	3.1	40.7	8.4	33.3	3.0			38.9
Ceratopogonidae			7.4	8.0			3.7	0.8	25.9	2.3	31.2	3.4	11.4
Tabanidae									3.7	0.3	14.6	1.6	1.0
Total	366.5	99.8	92.5	100.0	592.4	99.6	485.0	100.2	1122.0	99.8	902.6	99.9	591.5

Knife River Station 2

Nematoda					3.7	0.5					7.4	1.6	1.8
Oligochaeta	40.7	34.4	77.8	48.9	18.5	2.5	100.0	13.6	29.6	3.2	51.8	11.6	53.1
Hyalella azteca											3.7	0.8	0.6
Hexagenia sp.											29.6	6.6	4.9
Ephoron sp.							3.7	0.5	3.7	0.4			1.2
Baetis sp.					174.1	23.8	18.5	2.5	11.1	1.2	3.7	0.8	34.6
Caenis sp.									3.7	0.4	7.4	1.6	1.8
Isonychia sp.					18.5	2.5							3.1
Leptophlebia sp.											3.7	0.8	0.6
Stenonema sp.	3.7	3.1	14.8	9.3	59.3	8.1	46.2	6.6	181.5	19.9	107.4	24.0	69.2

(continues)

Organism	May Number Per M^2	May % of Total	June Number Per M^2	June % of Total	July Number Per M^2	July % of Total	August Number Per M^2	August % of Total	September Number Per M^2	September % of Total	October Number Per M^2	October % of Total	Avg. No. Per Sample
Heptagenia sp.					44.4	6.1							7.4
Gomphus sp.									3.7	0.4			0.6
Corixidae (A)											18.5	4.1	3.1
Sialis sp.							3.7	0.5	37.0	4.1	7.4	1.6	8.0
Hydropsyche sp.	25.9	21.9			14.8	2.0	18.5	2.5	133.3	14.6	3.7	0.8	32.7
Cheumatopsyche sp.	7.4	6.2			325.9	44.7	407.4	55.6	411.1	45.1	92.6	20.7	207.4
Polycentropus sp.					3.7	0.5							0.6
Elmidae (A)					11.1	1.5			3.7	0.4			2.5
Elmidae (L)	7.4	6.2									11.1	2.5	3.1
Tipulidae											14.8	3.3	2.5
Simulium (L)			33.3	20.9			25.9	3.5	51.8	5.7	37.0	8.3	24.7
Simulium (P)									7.4	0.8			1.2
Pentaneurini							3.7	0.5	11.1	1.2	3.7	0.8	3.1
Cryptochironomus sp.	3.7	3.1			14.8	2.0			3.7	0.4			3.7
Endochironomus sp.							59.3	8.1					9.9
Strictochironomus sp.			3.7	2.3									0.6
Microtendipes sp.	18.5	15.6			37.0	5.1	22.2	3.0			18.5	4.1	16.0
Tanytarsus sp.	3.7	3.1	18.5	11.6					3.7	0.4			4.3
Chironomidae (P)	3.7	3.1	7.4	4.6			3.7	0.5	3.7	0.4			3.1
Ceratopogonidae			3.7	2.3							22.2	5.0	4.3
Tabanidae							14.8	2.0	11.1	1.2	3.7	0.8	4.9
Sphaerium sp.	3.7	3.1			3.7	0.5	3.7	0.5					1.8
Total	118.4	99.8	159.2	99.9	729.5	99.8	733.3	99.9	910.9	99.8	447.9	99.8	516.4
Spring Creek Station 3													
Nematoda			18.5	13.5	7.4	1.4			3.7	0.4	11.1	1.0	6.9
Oligochaeta	40.7	28.2	22.2	16.2	111.1	21.0	33.3	3.1	88.9	9.3	29.6	2.6	54.3
Hyalella azteca					7.4	1.4					51.8	4.6	9.9
Perlesta sp.					3.7	0.7							0.6
Hexagenia sp.							11.1	1.0					1.8
Ephoron sp.					7.4	1.4	3.7	0.3	7.4	0.8			3.1
Baetis sp.			3.7	2.7	14.8	2.8	7.4	0.7	14.8	1.6	3.7	0.3	7.4
Tricorythodes sp.							11.1	1.0	3.7	0.4	3.7	0.3	3.1
Caenis sp.			3.7	2.7	18.5	3.5	3.7	0.3	11.1	1.2			6.2
Isonychia sp.					14.8	2.8	14.8	1.4	3.7	0.4			5.6
Leptophlebia sp.											3.7	0.3	0.6
Stenonema sp.			11.1	8.1					14.8	1.6	170.4	15.1	32.7
Gomphus sp.									7.4	0.8			1.2
Agrion sp.									3.7	0.4			0.6
Corixidae			3.7	2.7	7.4	1.4	329.6	30.9	240.7	25.1	3.7	0.3	97.5
Sialis sp.							14.8	1.4					2.5
Hydropsyche sp.	7.4	5.1	7.4	5.4	133.3	25.2	251.8	23.6	192.6	20.1	203.7	18.1	132.7
Cheumatopsyche sp.					55.7	10.5	244.4	22.9	277.8	29.0	337.0	29.9	152.5
Polycentropus sp.											3.7	0.3	0.6
Leptocella sp.					7.4	1.4							1.2
Agrypnia sp.											7.4	0.6	1.2
Elmidae (A)			3.7	2.7	11.1	2.1							2.5
Elmidae (L)			3.7	2.7	3.7	0.7	3.7	0.3	29.6	3.1	7.4	0.6	8.0
Tipulidae											70.4	6.2	11.7
Simulium sp. (L)	3.7	2.6	48.2	35.4	18.5	3.5	3.7	0.3	18.5	1.9	11.1	1.0	17.1
Simulium sp. (P)					14.8	2.8							2.5
Pentaneurini							3.7	0.3					0.6
Procladius sp.			3.7	2.7									0.6
Cryptochironomus sp.					3.7	0.7	11.1	1.0	3.7	0.4			3.1
Endochironomus sp.							40.7	3.8					6.9
Polypedilum sp.	18.5	12.8			3.7	0.7	3.7	0.3					4.3
Strictochironomus sp.	7.4	5.1											1.2
Microtendipes sp.	63.0	43.6			70.4	13.3	55.6	5.2	27.9	2.9	162.7	14.4	63.3
Diamesinae	3.7	2.6	3.7	2.7							14.8	1.3	3.7
Chironomidae (P)			3.7	2.7	7.4	1.4	7.4	0.7	3.7	0.4			3.7
Tabanidae							3.7	0.3					0.6
Physa sp.							3.7	0.3	3.7	0.4	18.5	1.6	4.3
Sphaerium sp.					7.4	1.4	3.7	0.3			11.1	1.0	3.7
Total	144.4	100.0	137.0	100.2	529.6	100.2	1066.4	99.4	957.4	100.2	1125.5	99.5	660.2
Knife River Station 4													
Nematoda	3.7	1.5	7.4	3.4	14.8	2.9	14.8	1.5					6.8
Oligochaeta	100.0	41.7	203.7	65.5	11.1	2.2	11.1	0.1	7.4	2.2	22.2	2.3	59.2
Ephoron sp.					74.1	14.5	3.7	0.4					13.0
Baetis sp.			11.1	3.6			29.6	3.0			7.4	0.8	8.0
Pseudocloeon sp.									3.7	1.1			0.6
Tricorythodes sp.							7.4	0.8					1.2
Caenis sp.	3.7	1.5			11.1	2.2					3.7	0.4	3.1
Isonychia sp.					11.1	2.2							1.8
Leptophlebia sp.											7.4	0.8	1.2
Stenonema sp.	18.5	7.7	3.7	1.2	44.4	8.7	85.2	8.6	111.1	33.7	303.7	31.1	94.4

(continues)

Organism	May Number Per M²	May % of Total	June Number Per M²	June % of Total	July Number Per M²	July % of Total	August Number Per M²	August % of Total	September Number Per M²	September % of Total	October Number Per M²	October % of Total	Avg. No. Per Sample
Heptagenia sp.					11.1	2.2	3.7	0.4	22.2	4.7			6.2
Gomphus sp.									11.1	3.4			1.9
Corixidae					11.1	2.2							1.8
Sialis sp.							3.7	0.4					0.6
Hydropsyche sp.	37.0	15.4	7.4	2.4	51.8	10.1	85.2	8.6	14.8	4.5	148.1	15.2	57.4
Chemmatopsyche sp.	25.9	10.8	7.4	2.4	151.8	29.7	588.9	59.6	18.5	5.6	351.8	36.0	190.7
Elmidae (A)					3.7	0.7							1.2
Elmidae (L)	7.4	3.1							7.4	2.2	3.7	0.4	3.1
Tipulidae											37.0	3.8	6.2
Simulium (L)			59.2	19.1					3.7	1.1	7.4	0.8	11.7
Simulium (P)					48.2	9.4							8.0
Pentaneurini	7.4	3.1					3.7	0.4	18.5	5.6			4.9
Chironomus sp.									7.4	2.3			1.2
Cryptochironomus sp.					7.4	1.4			14.8	4.5			3.7
Endochironomus sp.							81.5	8.2					13.6
Paratendipes sp.	3.7	1.5											1.2
Strictochironomus sp.			3.7	1.2									1.2
Microtendipes sp.	11.1	4.6			55.6	10.9	37.0	3.7	33.3	10.1	33.3	3.4	28.4
Tanytarsus sp.	11.1	4.6							7.4	2.2			3.1
Diamesinae			3.7	1.2									1.2
Cricotopus sp.	3.7	1.5	3.7	1.2									1.2
Chironomidae (P)	7.4	3.1			3.7	0.7	33.3	3.4	22.2	6.7			11.1
Ceratopogonidae									7.4	2.2	3.7	0.4	1.8
Tabanidae											48.1	4.9	8.0
Total	240.6	100.0	311.1	100.2	511.0	100.0	988.8	99.1	329.4	499.6	977.5	100.1	558.6
Knife River Station 6													
Nematoda	3.7	2.2	3.7	3.2	3.7	0.9							1.8
Oligochaeta	48.1	28.3	7.4	6.4			40.7	8.7	29.6	4.8	118.5	15.1	40.7
Perlesta sp.			3.7	3.2									0.6
Ephoron sp.					55.7	11.8							9.3
Baetis sp.			11.1	9.7	33.3	7.0			18.5	3.0	3.7	0.5	11.1
Tricorythodes sp.							11.1	2.4	3.7	0.6	3.7	0.5	3.1
Caenis sp.					22.2	4.7	18.5	3.9					6.8
Isonychia sp.			3.7	3.2			22.2	4.7					4.3
Leptophlebia sp.											25.9	3.3	4.3
Stenonema sp.					55.7	11.8	70.4	15.0	251.8	41.2	507.4	64.6	147.6
Heptagenia sp.					14.8	3.1	7.4	1.6	3.7	0.6			4.3
Gomphus sp.											3.7	0.5	0.6
Corixidae					140.7	29.7	111.1	23.6	63.0	10.3			52.5
Sialis sp.									11.1	1.8			1.8
Hydropsyche sp.			14.8	12.9	44.4	9.4			11.1	1.8	7.4	0.9	13.0
Chemmatopsyche sp.	3.7	2.2	40.7	35.5	14.8	3.1	118.5	25.2	114.8	18.8	85.2	10.8	63.0
Polycentropus sp.											3.7	0.5	0.6
Leptocella sp.									7.4	1.2			1.2
Astenophylx sp.			3.7	3.2									0.6
Elmidae (A)					3.7	0.9			3.7	0.6			1.2
Elmidae (L)	7.4	4.3									11.1	1.4	3.1
Tipulidae											7.4	0.9	1.2
Simulium (L)			11.1	9.7							7.4	0.9	3.1
Pentaneurini					7.4	1.6	3.7	0.8	3.7	0.6			2.5
Cryptochironomus sp.	33.3	19.6			40.7	8.6	11.1	2.4	37.0	6.1			20.4
Endochironomus sp.							14.8	3.2					2.5
Polypedilum sp.	48.1	28.3	3.7	3.2									8.6
Paralauterborniella sp.							7.4	1.6					1.2
Microtendipes sp.	3.7	2.2			7.4	1.6	14.8	3.2	37.0	6.1			10.5
Tanytarsus sp.	18.5	10.9			18.5	3.9							6.2
Chironomidae (P)	3.7	2.2	7.4	6.4	11.1	2.3	3.7	0.8	7.4	1.2			5.6
Ceratopogonidae			3.7	3.2			14.8	3.2	7.4	1.2			4.3
Total	170.2	100.2	114.7	99.8	474.1	100.4	470.2	100.1	610.9	99.9	785.1	99.9	437.6

[1] Adult

[2] Larvae

[3] Pupae

Source: Woodward-Envicon, Inc., Analysis, 1974.

Appendix H

Animal Numbers Lost During Construction and Mining

ESTIMATED NUMBERS OF INDIVIDUALS OF FAUNAL SPECIES CORRESPONDING TO EXPECTED HABITAT LOSS RESULTING FROM CONSTRUCTION OF THE PROPOSED COAL GASIFICATION FACILITY[1]

Birds[2]	Number of Individuals[3]
Eared grebe	3
Pied-billed grebe	2
Mallard	32
Pintail	22
Gadwall	5
Shoveler	39
Blue-winged teal	14
Ruddy duck	N
American coot	28
Sora	N
Killdeer	24
Upland plover	2
Willet	N
Wilson's phalarope	16
Black tern	N
Sharp-tailed grouse	P
Ring-necked pheasant	P
Gray partridge	P
Marsh hawk	P
Cooper's hawk	N
Swainson's hawk	P
Great-horned owl	P
Burrowing owl	N
Rock dove	N
Mourning dove	P
Black-billed cuckoo	N
Common nighthawk	P
Belted kingfisher	N
Yellow-shafted flicker	N
Eastern kingbird	9
Western kingbird	N
Eastern phoebe	N
Traill's flycatcher	N
Least flycatcher	N
Horned lark	44
Barn swallow	12
Tree swallow	N
Bank swallow	N
Rough-winged swallow	3
Blue jay	N
Black-billed magpie	N
Common crow	N
Catbird	N
Brown thrasher	N
Robin	3
Loggerhead shrike	N
Starling	N
Philadelphia vireo	N
Yellow warbler	N
Ovenbird	N
Yellowthroat	15
House sparrow	6
Bobolink	18
Western meadowlark	9
Yellow-headed blackbird	14

Birds[2]	Number of Individuals[3]
Red-winged blackbird	77
Brewer's blackbird	3
Common grackle	P
Brown-headed cowbird	8
Orchard oriole	N
Baltimore oriole	N
Rose-breasted grosbeak	N
American goldfinch	P
Dickcissel	5
Rufous-sided towhee	N
Grasshopper sparrow	P
Baird's sparrow	N
Lark bunting	118
Vesper sparrow	6
Clay-colored sparrow	7
Song sparrow	P
McCown's longspur	N
Chestnut-collared longspur	13
Mammals[4]	
Masked shrew	N
Thirteen-lined ground squirrel	P
Northern pocket gopher	P
Wyoming pocket mouse	P
Deer mouse	870[5]
Northern grasshopper mouse	P
Boreal red-backed vole	N
Prairie vole	N
House mouse	P
Meadow jumping mouse	P
Raccoon	1
Long-tailed weasel	P
Mink	N
Badger	P
Striped skunk	2
Coyote	P
Red Fox	1
Fox squirrel	N
Porcupine	N
White-tailed jackrabbit	2
Eastern cottontail	N
Mule deer	N
White-tailed deer	P
Pronghorn	20
Amphibians and Reptiles	
Blotched tiger salamander	N
Great Plains toad	N
Northern leopard frog	P
Western painted turtle	P
Plains garter snake	P
Red-sided garter snake	P
Western hognose snake	N
Yellow-billed racer	P
Smooth green snake	N
Bull snake	N

[1] Numbers given are based on 1974 population levels.

[2] Numbers represent the estimated spring (breeding) populations based on site specific field studies.

[3] N = not observed on proposed plant site; known to occur in the vicinity; P = present in low unknown numbers.

[4] Based on estimated fall population levels.

[5] Based on site specific trapping studies.

Source: Woodward-Envicon, Inc., 1974

ESTIMATED NUMBERS OF INDIVIDUALS OF RESIDENT FAUNAL SPECIES CORRESPONDING TO 12,500 ACRES OF TERRESTIAL HABITAT INCLUDED IN PROPOSED SURFACE MINES BASED ON 1974 POPULATION LEVELS

Birds[1]	Estimated No. of Individuals[2]	Generalized Habitat Utilization[3]			
		Agricultural	Prairie	Wetland	Wooded
Eared grebe	P			N,F	
Pied-billed grebe	P			N,F	
Mallard	10			N,F	
Pintail	P			N,F	
Gadwall	10			N,F	
Shoveler	P			N,F	
Blue-winged teal	15			N,F	
Ruddy duck	P			N,F	
American coot	P			N,F	
Sora	P			N,F	
Killdeer	195	N,F	N,F	N,F	
Upland plover	120		N,F		
Willet	P			N,F	
Wilson's phalarope	P			N,F	
Black tern	P			N,F	
Sharp-tailed grouse	30	F	N,F		F,W
Ring-necked pheasant	50	N,F	F		F,W
Gray partridge	P	N,F	F		W
Cooper's hawk	2				N,F
Marsh hawk	5	F	N,F	F	
Swainson's hawk	2	F	F		N
Great-horned owl	2	F	F	F	N,F
Burrowing owl	2		N,F		
Rock dove	P	N,F			
Mourning dove	135	F	F		N
Black-billed cuckoo	P				N,F
Common nighthawk	P	N,F	F	F	N,F
Belted kingfisher	P			F	N
Yellow-shafted flicker	P				N,F
Eastern kingbird	250	F	F		N,F
Western kingbird	P	F	F		N,F
Eastern phoebe	P				N,F
Traill's flycatcher	P				N,F
Least flycatcher	P				N,F
Horned lark	1600	N,F	N,F		
Barn swallow	P	N,F	F	F	F
Tree swallow	P	F	F	F	N,F
Bank swallow	P	F	F	N,F	
Rough-winged swallow	P	F	F	N,F	
Blue jay	P				N,F
Black-billed magpie	P	F	F		N,F
Common crow	P	F	F		N,F
Cat bird	P				N,F
Brown thrasher	P	F	F		N,F
Robin	95	F	F		N,F
Loggerhead shrike	P	F	F		N,F
Starling	P	N,F	F		N,F
Philadelphia vireo	P	F	F		N,F
Yellow warbler	80				N,F
Ovenbird	P				N,F
Yellow throat	80			N,F	N,F
House sparrow	95	N,F			N
Bobolink	155	N,F		N,F	
Western meadowlark	915	N,F	N,F		
Yellow-headed blackbird	P			N,F	
Red-winged blackbird	605	N,F	F	N,F	
Brewer's blackbird	275	N,F			
Common grackle	P	F			N
Brown-headed cowbird	820	N,F	N,F		N
Orchard oriole	P				N,F

(cont'd-1)

Birds[1]	Estimated No. of Individuals[2]	Generalized Habitat Utilization[3]			
		Agricultural	Prairie	Wetland	Wooded
Baltimore oriole	P				N,F
Rose-breasted grosbeak	P				N,F
American goldfinch	P	F	F		N
Dickcissel	P	N,F			
Rufous-sided towhee	P				N,F
Grasshopper sparrow	135	N,F	N,F		
Baird's sparrow	P	N,F	N,F		
Lark bunting	1800	N,F	N,F		
Vesper sparrow	215	N,F	N,F		
Clay-colored sparrow	275				N,F
Song sparrow	P	F	F		N
McCown's longspur	P		N,F		
Chestnut collared longspur		N,F	N,F		
Mammals[5]					
Masked shrew	60	X			X
Thirteen-lined ground squirrel	950	X	X		
Northern pocket gopher	6100	X	X		
Wyoming pocket mouse	300	X			
Deer mouse	15000	X	X		X
Northern grasshopper mouse	800	X	X		
Boreal red-backed vole	P				X
Prairie vole	P	X	X		
House mouse	250	X			
Meadow jumping mouse	P				X
Raccoon	23	X	X	X	X
Long-tailed weasel	P	X	X		X
Mink	P			X	
Badger	P	X	X		
Striped skunk	35	X	X	X	X
Coyote	4	X	X	X	X
Red fox	12	X	X	X	X
Fox squirrel	P				X
Porcupine	P				X
White-tailed jackrabbit	37	X	X		
Eastern cottontail	P				X
Mule deer	P		X		X
White-tailed deer	4	X	X		X
Pronghorn	13	X	X		
Amphibians and Reptiles					
Blotched tiger salamander	P	X		X	X
Great Plains toad	P		X	X	
Northern leopard frog	P			X	
Western painted turtle	P			X	
Plains garter snake	P	X	X	X	
Red-sided garter snake	P	X	X	X	
Western hognose snake	P	X	X		
Yellow-bellied racer	P	X	X		
Smooth green snake	P		X		X
Bull snake	P	X	X		

[1] Population levels of bird species pertain to the breeding season (spring).

[2] P = Present in low unknown numbers.

[3] N = nesting, F = feeding, W = wintering.

[4] Population levels of mammal species pertain to fall.

Source: Woodward-Envicon, Inc, 1974.

Appendix I

ANGCGC's Air Quality Dispersion Analysis

SUMMARY

This report summarizes the dispersion analyses used to evaluate the impact on the air quality resulting from the construction and operation of the proposed ANG Coal Gasification Plant and Basin Electric proposed coal fired electric generating stations. The dispersion modeling was based upon techniques and methods developed by the Environmental Protection Agency as published in the Workbook of Atmospheric Dispersion Estimates and Guidelines for Air Quality Maintenance Planning and Analysis, Volume 10 Reviewing New Stationary Sources. Whenever possible the programs available in EPA's UNAMAP model were utilized. An additional subroutine was added to the PTDIS, PTMAX and PTMPT programs in order to allow for the evaluation of emissions from sources with jet (non-bouyant) plumes. The program modification is described in the Appendix. Existing power plants and those proposed power plants which have been granted a water permit prior to the preparation of this report were also considered.

Based upon the estimated concentrations obtained through dispersion modeling and using preliminary engineering information the proposed joint projects will meet all applicable North Dakota and Federal ambient air standards, including the significant deterioration Class II standards for sulfur dioxides and Class II for total suspended particulates.

A. Description of Air Emissions Resulting From the Proposed Project

The following report analyzes the air emissions generated during construction and operation of the proposed ANG Coal Gasification Plant and Basin Electric proposed electric generating facility. The impact on the air quality resulting from the growth associated with the project is also discussed.

Fugitive dust emissions created during plant construction and emissions generated from the construction equipment are evaluated in Section C. These emissions are summarized in Table I.

In Section D the air emissions resulting from the operation of the proposed project are analyzed. These emissions include: those emissions generated by the combustion of coal fines in the Basin's steam generators and by the combustion of tar by-products in the superheaters (sulfur dioxide, nitrogen dioxide, hydrocarbons, carbon monoxide, and particulates); the particulate emissions from the coal handling operations, and the fugitive dust emissions created by the mining operations. Intermittent emissions from ANG's start-up incinerator, refuse incinerator and flares are also considered. The emission rates, stack design data and the location of each of the above sources, are summarized in Table II.

The majority of the hydrocarbon emissions from the gasification plant are controlled either by incineration in the superheaters or by flaring (Table II). However, small intermittent quantities of hydrocarbons will also be released from the by-product storage area. The hydrocarbon emissions from the storage area are given in Page 162 of the application. The dispersion of the emissions from the storage area will be very localized, and therefore, the effects of these hydrocarbon emissions were not evaluated.

Although it is frequently cited that the operation of a coal gasification plant will increase the formation of photochemical oxidants in a region (Northern Great Plains Resource Program (NGPRP), and Nordesick, et.al) an increase in the oxidant level due to the operation of ANG's plant is not anticipated. The formation of photochemical oxidants is dependent not only on the ambient NO_x concentration but also the ambient hydrocarbon concentration. As previously cited, the hydrocarbon emissions are well controlled. Furthermore, as stated in ANG's Environmental Impact Report (EIR), the background hydrocarbon concentration in the area is well below state and federal

TABLE I

ON-SITE AIR EMISSIONS DURING CONSTRUCTION
PHASE USED FOR DISPERSION MODELING

VEHICLE EMISSIONS (1):	MAXIMUM EMISSION RATE (lb/hr)
Total Suspended Particulates	3.43
Sulfur Oxides	6.83
Carbon Monoxide	57.25
Hydrocarbon	9.38
Nitrogen Dioxide	92.68
FUGITIVE DUST EMISSIONS (2): From The Total Construction Site	1025.80

(1) Emissions are based on the data presented in Table 3.1.41 of ANG's EIR, assuming the simultaneous operation of 20 heavy duty diesel engines and 20 light duty gasoline engines for a 16-hour work day.

(2) Emissions are based on a particulate emission factor of 1.2 ton/acre-month of heavy construction. A 50% reduction for watering was also assumed. 636 acres will be under construction during site preparation which will begin in March, 1976. The heavy construction will last approximately four months. Due to wind erosion, it was assumed that fugitive dust would be generated 24 hours per day.

TABLE II

SUMMARY OF SOURCE IMPUT DATA
FOR UNAMAP PROGRAMS

SOURCES	STACK HEIGHTS (2) (M)	STACK DIAMETER (M)	STACK DATA STACK GAS EXIT VELOCITY (M/SEC)	STACK GAS VOLUME (M^3/SEC)	STACK GAS TEMPERATURE (K°)	MAXIMUM EMISSION RATES (g/sec) SO_2	NO_x	TSP	CO	HC	LOCATION (1) X Km	Y Km
ANG Mainstack (3)												
E010	121.92	7.32	15.43 (14.88)	649.40 (626.62)	483.0	679.39 (333.21)	138.60	21.42	45.36	16.34	8.43	8.37
Main Flares (5)												
E020A	60.96	4.33 (4)	219.45	3232.80 (4)	1588.75	1139.04	Neg.	Neg.	Neg.	Neg.	9.14	7.44
E020B	60.96	4.33 (4)	219.45	3232.80 (4)	1588.75	1139.04	Neg.	Neg.	Neg.	Neg.	9.34	7.49
Coal Handling												
E101	9.14	1.52	15.24	25.96	294.10 (7)	-	-	1.18	-	-	8.99	8.64
E102	9.14	1.75	15.24	36.82	294.10	-	-	1.69	-	-	9.01	8.79
E103	9.14	1.60	15.24	29.26	294.10	-	-	1.33	-	-	9.03	8.68
E104	9.14	1.68	15.24	32.10	294.10	-	-	1.47	-	-	8.95	8.96
E105	9.14	0.84	15.24	7.55	294.10	-	-	0.34	-	-	9.08	8.96
E106	9.14	0.61	15.24	4.01	294.10	-	-	0.19	-	-	8.63	9.42
E107	9.14	2.59	15.24	77.88	294.10	-	-	3.57	-	-	8.62	8.69
E108	9.14	1.75	15.24	36.82	294.10	-	-	1.69	-	-	8.63	8.95
E110	9.14	0.76	15.24	6.37	294.10	-	-	.29	-	-	9.07	7.72
Start-Up Incinerator (5)												
E201	48.76	3.66	30.34	319.20	1366.50	145.90	Neg.	Neg.	Neg.	Neg.	8.62	8.76
Phenosolvan Gas (6) Liquor Separator Flare												
E207	36.58	0.77(4)	57.91 (25.81)	27.30(4) (12.02)(4)	1588.75	74.90 (27.50)	Neg.	Neg.	Neg.	Neg.	8.85	8.50
Refuse Incinerator (5)												
E600	9.14	0.56	6.36	1.60	977.40			0.25	Neg.	Neg.	Not Defined	
Basin Unit #1	182.88	6.92	21.30	802.60	356.90	718.0	299.2	59.85	Neg.	Neg.	8.50	9.49
Basin Unit #2	182.88	6.92	21.30	802.60	356.90	718.0	299.2	59.85	Neg.	Neg.	8.50	9.57

(1) For PTMPT program the origin was assumed to be the point 5 miles west and 5 miles south of the common corner of Section 23, 24, 25 and 26.

(2) For PTMAX and PTDIS programs the stack heights given in the table were adjusted (reduced by 21.34 meters) to reflect the difference in the elevation of the plant site (1930') and the surrounding terrain (2000').

(3) Includes the intermittent emissions from the shift catalysts regeneration unit; ( ) does not include the regeneration unit.

(4) Based on the heat released and the design exit velocity the equivalent volume and equivalent diameter of the flare were calculated and used as input data.

(5) Intermittent

(6) Maximum case during upset conditions, ( ) values assumed during normal operations.

(7) Ambient temperature.

TABLE III INVENTORY OF EXISTING AND PROPOSED POWER PLANTS
NORTH DAKOTA - NRDA - AQMA

Plant Name	Owned By	Unit #	Megawatts	Startup Date	Diam M	Velocity M/S	Temp °K	Height M	TSP g/sec	SO_2 g/sec	NO_2 g/sec
Montana-Dakota Utilities Beulah, N.D.	Montana-Dakota Utilities Bismarck, N.D.	1	2.8	Existing	1.7	6.4	447	22.6	4.2	4.0	2.4
		2	2.8	Existing	1.7	6.4	447	22.6	4.2	4.0	2.4
		3	2.8	Existing	1.7	6.4	458	26.5	6.1	4.6	2.8
		4	2.8	Existing	1.5	9.7	491	22.6	24.0	11.6	7.1
		5	2.8	Existing	1.5	9.7	491	22.6	24.0	11.6	7.1
Leland Olds Power Plant Stanton, N.D.	Basin Electric Power Coop Bismarck, N.D.	1	210	Existing	5.3	23.6	466.3	106.7	1.5	453	341
		2	450	Sept. 75	6.7	18.3	455.2	152.4	2.8	988	---
Milton R. Young Power Plant Center, N.D.	Minnkota Power Coop Grand Forks, N.D.	1	235	Existing	5.8	21.3	450	76.2	22	807	345
Milton R. Young Power Plant Center, N.D.	Square Butte Electric Coop Grand Forks, N.D.	2	450	March 76	9.1	14.0	440	152.4	20	699	482
United Power Association Stanton, N.D.	United Power Association Elk River, MN	1	180	Existing	4.6	22.9	450	77.7	22	513	237
Coal Creek Station Underwood, N.D.	UPA/CPA Elk River, MN	1	545	Late 1978	6.4	27.1	523	198	45	879	---
		2	545	Late 1979	6.4	27.1	523	198	45	879	---

ambient air standards.

Emissions from other sources listed in attachment AP-100-II are either negligible or the ambient air quality standards listed in R 23-25-02 are not applicable.

To predict compliance with State and Federal sulfur dioxide (SO_2), nitrogen dioxide (NO_x), total suspended particulates (TSP), carbon monoxide (CO), and hydrocarbons (HC), ambient air standards the cumulative impact of the joint venture and the existing and proposed sources in the area were examined. The nearest existing power plant to the proposed plant site is MDU's small 14.0 megawatt power plant in Beulah. It is located approximately 7.5 miles south by southwest of ANG's proposed plant site. Because of the close proximity of MDU's Beulah Station and the proposed plant site, the combined emissions from these facilities may affect the short-term (e.g., one-hour, three-hour, etc.) air quality. The long-term impact (annual average) on the air quality of the region may be affected not only by MDU's Beulah station but also by other existing and proposed power plants within a 35-mile radius of the proposed ANG and Basin plant sites. A listing of the major sources and the other pertinent emission and engineering data was obtained from the North Dakota State Health Department and is summarized in Table III.

The impact of the air emissions resulting from growth associated with the project's development and operation is discussed in Section E.

B. Meteorological Data

As discussed in Section 2 of the EIR, ANG has maintained a meteorological tower in the vicinity of the proposed plant site since February, 1974. The vertical temperature gradient recorded during the period from February through December, 1974 has been categorized according to the associated stability class. The frequency of occurrence of the three main stability classes are summarized below:

Vertical Temperature Gradient °C/100m	Stability Category	Pasquill Stability Class	% Frequency of Occurrence *
-1.9 to -1.5	Unstable	A, B, C	24.5
-1.5 to 0.5	Neutral	D	28.5
0.5 to 4.0	Stable	E, F, G	47.0

* Based on 7477 hours of observations from February through December, 1974.

Under stable conditions, which at the plant site occured most frequently during the nighttime, late evening and early morning hours, the buoyancy of a plume decays as it rises. A hot plume emitted from tall stacks will rise until it reaches a layer where the density of the air diluted plume is the same as the density of the surrounding air. As the equilibrium is achieved the plume will retain its effective height for many miles since the air below the plume is cooler and the air above the plume is warmer. Under stable conditions there is very limited veritical mixing of the plume. However, there is gradual horizontal spreading. The ground-level concentration below such plumes are negligible. Wind speeds from 2-5 m/sec were used for the dispersion analyses for stable conditions.

Neutral atmospheric stability conditions are usually brought about by vigorous atmospheric mixing. The atmospheric turbulence increases the rate of plume dilution. For this region of North Dakota over 75% of the wind speeds associated with this stability class were over 12 mph . Under these conditions the plume disperses rapidly and generally fits a coning model. The ground-level concentrations under neutral conditions were predicted for wind speeds varying from 0.5 to 20.0 m/sec.

Under unstable conditions the buoyancy of a plume increases as it rises. On warm afternoons, with light winds, hot plumes may rise several thousand feet. On very unstable days large vertical velocity fluctuations may develop due to strong convection eddies created by the warming of air masses near the earth's surface. This large-scale vertical mixing causes the

plume to loop. High transitory maximum ground-level pollutant concentrations relatively near the source will occur under these conditions. In this region of the State, the unstable conditions are mostly concentrated during late morning and afternoon hours. Wind velocities associated with these stability conditions were generally (approximately 88% of the time) under 12 mph (1).

High transitory ground-level pollutant concentrations may also be experienced during early morning inversion breakup and other transit periods when the temperature inversion breakup occurs. Due to relatively cloud-free skies and low humidities of this region, nocturnal radiative heat losses may be quite large. Large nocturnal heat losses from the ground result in the air next to the ground being cooled more rapidly than the air aloft, and an inversion is formed. In this stable layer which may be several thousand feet high; hot plumes emitted from tall stacks will rise until they reach a level where the density of the air-diluted plumes is the same as the surrounding air. As the plumes lose their buoyancy, they become trapped in a narrow vertical band aloft since the air below the plume is cooler and the air above the plume is warmer. Such trapped plumes may then drift with the winds at this level for 20 or more miles. Because of this inverted temperature profile, ground-level pollutant concentrations below such plumes will be negligible.

As the sun rises, the incoming solar radiation heats the ground surface and thermal eddies develop. If the incoming solar radiation is sufficiently strong, the thermal eddies will spread from the ground upward to the level where the pollutant-bearing plume has been trapped aloft, they rapidly mix with the plume pulling it towards the ground. The inversion aloft

(1.) Based on analyses of ten year meteorological data tapes for Bismarck, Minot, Williston and Dickinson, North Dakota obtained from the National Climatological Center.

prevents upward dispersion. This "inversion breakup" or fumigation is short-lived but can result in high ground level concentrations for short periods of time.

Early morning fumigation may last from several minutes to 30 minutes depending upon the meteorological conditions. On the average, in this region, it lasts only 15 minutes (Packnett, 1973). The highest ground level concentrations will result from very stable air and light winds. Stability class F and 1.0 m/sec wind speed were selected as representative. Pollutant concentration calculations, however, must be made for fumigating conditions for comparison with short term (one hour) State ambient air standards. The stability category following inversion break-up might be either neutral or unstable. For the purposes of these calculations, stability class C with 2.0 m/sec wind speeds were chosen as representative. The maximum concentration also will occur when the base of the inversion is as low as possible, but high enough to trap all of the plumes from all the sources. Various inversion heights were examined to determine which heights meet this criterion.

On some occasions (i.e., heavy cloud covering) the incoming solar radiation is not strong enough to produce surface heating which will completely destroy the nighttime surface inversion. This condition may also occur when incoming solar radiation is reflected from snow covered ground. When this occurs the inversion will be eliminated to some level aloft, resulting in slightly unstable or neutral conditions at the lower levels, and inversion layer aloft. If the inversion layer is high enough so that the hot plumes cannot penetrate through the layer, the plume may become "trapped" below the inversion layer. Since the dispersion of the plume is limited high maximum ground-level concentrations may be experienced under these conditions.

C. Estimate of Ambient Air Quality Deterioration During Plant Construction

To determine compliance with Federal and State ambient air standards the maximum ground level concentration resulting from the construction activities was estimated, using the procedures to evaluate area sources which are described by Turner (1969). Using Turner's procedures the fugitive dust emissions and the vehicle emissions were combined, and these areawide emissions were treated as a point source having an initial horizontal standard deviation (σ_{yo}). Using σ_{yo}, the virtual distance (χ_y) was found and the appropriate values of the horizontal standard deviation (σ y) were determined, for various downwind distances.

In performing these calculations it was assumed that:

- the peak construction activity will occur during site preparation and that all 636 acres will be under construction during this period.
- the plant site (area emission grid) is approximately 1 mile square.
- the emissions in Table I are continuous and uniformly distributed over the emission grid.
- all sources within the grid are ground-level sources (effective stack height = 0)
- fugitive dust emissions created by the construction activity which are greater than 100 μm in diameter will quickly settle out (Hazen and Wooduff, 1973).
- 60% of the fugitive dust emissions listed in Table I are within the suspended particulate size range (EPA, 1974), and that only 40% of particles within this range will be carried in suspension. (Chepil,1945, estimated that 3 to 40 percent of the dust particulates smaller than 100 μm could be

carried in suspension).

Based on these assumptions, the Pasquill-Turner diffusion equation can be simplified:

$$x = \frac{Q}{\pi \sigma_y \sigma_z u}$$

and the initial value was approximated by $\sigma_{yo} = S/4.3$ where S is equal to the length of the emission grid. Using the calculated value of σ_{yo} the virtual distance $-x_y$ was determined using Figure 3.2 of Turner's Workbook of Atmosphere Dispersion.

Since the vertical and horizontal dispersion coefficients presented in Figure 3.2 and Figure 3.3 (Turner, 1969) are generally representative of 10-minute averaging times the predicted ground-level concentrations are also representative of 10-minute averages. The North Dakota State Health Department, Division of Environmental Engineering suggests that for this particular region the predicted concentration for Stability Class A and B be considered to be representative of 10-minute averaging times, Stability Class C - one hour, Stability Class D - 3 hours and Stability Classes E and F - 10 minutes to one hour. To convert the model predicted concentration to concentrations with time intervals equal to State and Federal standards, the North Dakota State Health Department also suggested that the following equation be used:

$$X_2 = X_1 \left[\frac{t_2}{t_1}\right]^{-B}$$

where X_1 = concentration predicted by the UNAMAP model

X_2 = adjusted concentration

t_1 = time interval predicted by model

t_2 = adjusted time interval

$B = 0.44$

To determine compliance to the State's one-hour ambient air standards for SO_2, NO_x and CO, the relative ground level concentration under worst case conditions (Stability Class F with low wind speeds) was estimated. Meteorological records gathered at the plant site indicated that during the daytime hours neutral stability conditions are most prevalent. Therefore, since most of the construction activity will occur during daytime hours, the relative ground level concentrations representative of longer averaging times were calculated for neutral stability conditions (Stability D) with moderate winds (7 m/sec).

The results of these computations are summarized in Table IV. As indicated in the Table, all applicable North Dakota and Federal ambient air standards including significant deterioration Class II standards will be maintained during the plant construction phase.

Fugitive dust emissions will be localized and largely intermittent. Ambient dust levels should not be significantly greater than current levels that might occur during periods of heavy agricultural activity.

TABLE IV

ESTIMATED GROUND LEVEL POLLUTANT CONCENTRATION
DURING THE CONSTRUCTION PHASE

POLLUTANT	AVERAGING PERIOD	MAXIMUM ESTIMATED CONCENTRATION[1] I[2]	MAXIMUM ESTIMATED CONCENTRATION[1] II[2]	NORTH DAKOTA AMBIENT AIR STANDARDS	NATIONAL STANDARDS AMBIENT AIR PRIMARY	NATIONAL STANDARDS AMBIENT AIR SECONDARY	FEDERAL AND STATE SIGNIFICANT DETERIORATION CLASS II
SO_2 (ug/m^3)	1-hour	18.2	12.0	715 [3]	-	-	No classification
	3-hour	2.0	1.1	-	-	1300 [4]	700 [5]
	24-hour	0.8	.4	260 [3]	365 [4]	-	100 [5]
NO x (ug/m^3)	1-hour	100.2	65.8	200 [6]	-	-	No classification
CO (mg/m^3)	1-hour	0.3	0.2	40 [4]	40 [4]	40 [4]	No classification
	8-hour	0.16	0.09	10 [4]	10 [4]	10 [4]	No classification
HC (ug/m^3)	3-hour (6 to 9 a.m.)	2.7	1.5	160 [4]	160 [4]	160 [4]	No classification
TSP (ug/m^3)	24-hour [4]	27.8	15.6	150 [4]	260	150	30.0

1. One hour estimates are based on: Stability Class F; 2.0 m/sec wind speed. σ_{YO} = 374; χ_Y = 14.0 Km [Figure 3.2 (Turner)] therefore:

	I	II
x (Km)	1.61	3.22
x + Xy (Km)	15.6	17.22
σ z (m)	19	27
σ y (m)	410	440
x/Q ($\frac{sec}{m^3}$)	2.04×10^{-5}	1.34×10^{-5}

all other estimates are based on: Stability Class D; 7.0 m/sec wind speed. σ_{YO} = 374; χ_Y - 6.4 [Figure 3.2 (Turner)] therefore:

	I	II
x (Km)	1.61	3.22
x + xy (Km)	8.01	9.62
σ z (m)	44	67
σy (m)	460	540
x/Q ($\frac{sec}{m^3}$)	2.25×10^{-6}	1.26×10^{-6}

2. I. Maximum ground level concentration 1/2 mile downwind of the plant site boundary. (1.61 Km from the center of the emission grid.)

   II. Maximum ground level concentration 1-1/2 mile downwind of the plant site boundary. (3.22 Km from the center of the emission grid.)

3. Maximum concentration.

4. Maximum concentration not to be exceeded more than one per year.

5. Maximum allowable incremental increase.

6. Maximum concentration not to be exceeded over 1% of the time in any three month period.

D. Estimates of Ambient Air Quality Deterioration During Plant Operation

To determine compliance with Federal and State ambient air quality standards, both the short-term and long-term pollutant concentrations were predicted.

1. One Hour Standards

The State of North Dakota ambient air standard for sulfur dioxide (SO_2) and carbon monoxide (CO) are expressed in terms of maximum one-hour concentration. The State's one-hour standard for nitrogen dioxide is not to be exceeded over 1% of the time in any three month period. Therefore, to determine compliance to State standards, pollutant concentrations occurring not only during non-inversion cases, but also those concentrations resulting from inversion break-up and plume trapping must be examined.

Non-Inversion Cases

Under non-inversion conditions the short term maximum ground-level concentrations for each individual source were estimated using the PTMAX program of the EPA UNAMAP model. The PTMAX program utilizes the Briggs plume rise equations and assumes a steady state Gaussion plume model. For non-buoyant plumes, jet plume rise equation was utilized (See Appendix). The input data used for the program is summarized in Table II. The stack heights were corrected to reflect the difference in elevation of the plant site and the nearby surrounding terrain. Since the programs in the UNAMAP package use the vertical and horizontal dispersion coefficients presented in Figure 3.2 and 3.3 of Turner's Workbook of Atmospheric Dispersion Estimates, the predicted concentrations are generally representative of 10-minute averaging times. To convert the model predicted concentration to concentrations with time intervals equal to State and Federal standards, the procedure recommended by the North Dakota State Health Department was used.

The results of PTMAX programs for SO_2, CO, and NO_2 emission, adjusted to reflect one-hour averaging time, are summarized in Table V, VI, and VII, respectively.

To evaluate the short term cumulative impact of all the sources the PTDIS and PTMPT programs were used. The PTDIS program was used to evaluate the ground level pollutant concentration as a function of downwind distance from the source. Based on the output of the PTDIS programs, the locations of various receptors were chosen for usage in PTMPT programs. The short-term cumulative impact from the various sources are given in Table VIII.

TABLE V

ESTIMATED MAXIMUM ONE-HOUR GROUND LEVEL SO_2 CONCENTRATION FOR NON-INVERSION CASES

SOURCE	VARIABLES	STABILITY CONDITIONS A	B	C	D	E	F
E010	u (m/sec)	3.0	5.0	15.0	20.0	2.0	(2)
	d (Km)	1.2	3.2	3.1	9.6	51.1	
	x ($\mu g/m^3$)	88.9	43.5	108.4	73.7	24.4	
E020	u (m/sec)	(2)	5.0	15.0	20.0	5.0	(2)
(A or B)	d (Km)		9.7	8.6	8.6	97.7	
	x ($\mu g/m^3$)		8.2	28.6	14.7	7.9	
E201	u (m/sec)	3.0	5.0	15.0	20.0	2.0	2.0
	d (Km)	1.2	2.8	2.1	4.7	27.0	79.0
	x ($\mu g/m^3$)	22.1	12.4	48.2	7.8	14.0	5.8
E207	u (m/sec)	3.0	5.0	15.0	20.0	2.0	2.0
	d (Km)	0.6	0.8	0.5	0.8	6.3	11.9
	x ($\mu g/m^3$)	88.6	76.6	299.4	426.0	72.7	63.1
Basin (3)	u (m/sec)	3.0	5.0	10.0	15.0	2.0	(2)
(Both	d (Km)	1.1	2.8	4.1	14.2	67.0	
Units)	x ($\mu g/m^3$)	250.8	116.8	209.0	114.4	37.6	

(1.) The concentrations derived from the PTMAX program were adjusted to reflect one hour averaging times. The formulas supplied by the North Dakota State Health Department were used to derive the time correction factors.

(2.) No concentration estimates were attempted since the distance to the point of maximum concentration is so great that the same stability is not likely to persist long enough for the plume to travel this far.

(3.) Due to close proximity of unit 1 and unit 2 the emissions are treated as being generated from one unit.

(4) Based on maximum emissions during upset conditions.

TABLE VI. ESTIMATED MAXIMUM ONE-HOUR GROUND LEVEL CO CONCENTRATION FOR NON-INVERSION CASES

SOURCE		STABILITY CONDITIONS					
		A	B	C	D	E	F
E010	u(m/sec)	3.0	5.0	15.0	20.0	2.0	(2)
	d(Km)	1.2	3.2	3.1	9.6	51.1	
	x(mg/m^3)	0.002	0.001	0.003	0.002	0.0006	

1. The concentration derived from the PTMAX program were adjusted to reflect one hour averaging times. The formulas supplied by the North Dakota State Health Department were used to derive the time correction factors.

2. No concentration estimate was attempted since the distance to the point of maximum concentration is so great that the same stability is not likely to persist long enough for the plume to travel this far.

TABLE VII

ESTIMATED MAXIMUM ONE-HOUR GROUND LEVEL NO_x CONCENTRATION FOR NON-INVERSION CASES

SOURCE	STABILITY CONDITION					
	A	B	C	D	E	F
E010 u(m/sec)	3.0	5.0	15.0	20.0	2.0	(2)
d(Km)	1.2	3.2	3.1	9.6	51.1	
x($\mu g/m^3$)	18.1	8.9	22.1	15.0	5.0	
Basin u(m/sec)	3.0	5.0	10.0	15.0	2.0	(2)
d(Km)	1.1	2.8	4.1	14.2	67.0	
x($\mu g/m^3$)	104.5	48.7	87.2	47.7	15.7	

1. The concentrations derived from the PTMAX program were adjusted to reflect one hour averaging times. The formulas supplied by the North Dakota State Health Department were used to derive the time correction factors.

2. No concentration estimate was attempted since the distance to the point of maximum concentration is so great that the same stability is not likely to persist long enough for the plume to travel this far.

3. Due to close proximity of unit 1 and unit 2 the emissions are treated as being generated from one unit.

TABLE VIII

CUMULATIVE IMPACT FOR NON-INVERSION CONDITIONS

POLLUTANT	MAXIMUM ONE-HOUR CONCENTRATION ($\mu g/m^3$)	WIND DIRECTION	WIND SPEED (m/sec)	STABILITY CLASS	DISTANCE TO MAXIMUM (1) (Km)
SO_2	283.2	S	15.0	C	5.1
NO_x	98.9	S	15.0	C	5.1

(1) The cumulative effects were evaluated only at receptor sites outside the plant boundaries. The distance given is the distance from ANG's main stack.

Inversion Breakup:

The maximum ground-level concentration during inversion breakup (fumigation) was approximated using the following equation (Turner, 1970):

$$(i) \quad X_F = \frac{Q}{(2\pi)^{0.5} \sigma_{yF} h_i u}$$

where

X_F = estimated maximum fumigation concentration (g/m^3)'

Q = pollutant emission rate (g/sec.)

$\sigma_{yF} = \sigma_y + \frac{H}{8}$ (m)

σ_y = horizontal dispersion standard deviation (m)

$H = h + \Delta h$ = effective stack height (m)

h = physical stack height (m)

Δh = plume rise (m)

$h_i = H + 2\sigma_Z$ (m) = height of the base of the inversion

σ_Z = vertical dispersion standard deviation (m)

u = mean wind speed in the stable layer (m/sec.)

Equation (i) however, cannot be used near the stack. The nearest downwind distance which can be considered for an estimate of the maximum fumigation concentration must be great enough, based on the time required, to eliminate the inversion. Hewson (1945) suggested that the time required to eliminate the inversion be estimated by the following equation:

$$(ii) \quad t = \frac{h_i^2 - h^2}{4K}$$

where

K = eddy diffusivity for heat = 3 m^2/sec^4

h_i = height of base of the inversion (m)

h = physical stack height (m)

Therefore, the nearest distance at which equation (i) should be applied is:

$$(iii) \quad X = Ut = U \frac{(h_i^2 - h^2)}{4K}$$

where X = distance to fumigation (m)

U = mean wind speed through the stable layer

The plume rise (Δh) for a bouyant plume in calm winds into stable air was approximated using the formula derived by Briggs.

(iv) $$\Delta H = 5 F^{0.25} \left[\frac{g}{T} \left(\frac{\partial \theta}{\partial Z} \right) \right]^{-0.375}$$

where

$F = 2.45 V_s d^2 \frac{(Ts - T)}{T_S}$ buoyancy flux (m^4/sec^3)

Vs = stack exit velocity (m/sec)

d = stack exit diameter (m)

Ts = stack exit temperature (K^o)

T = ambient air temperature (K^o)

g = 9.8 gravitional acceleration (m/sec^2)

$\frac{\partial \theta}{\partial Z}$ = 0.035 = vertical potential temperature gradient ($^oK/m$)

Using the preliminary engineering design data given in Table II, the plume rise from the main stack was calculated for 1 m/sec wind speed and 65°F ambient air temperature (Table IX). Due to their high heat capacities it was assumed that the plumes from the flares and the start-up incinerator could penetrate the strongest inversions, and that special case of inversion breakup was not applicable to these sources.

Equation (i) approximates the maximum fumigation concentration assuming that the inversion has been eliminated up to the height approximated by the definition of h_i. Various values of the vertical dispersion coefficient (σ_z) were then reexamined (Figure 3-3, Workbook of Atmospheric Dispersion Estimates) to determine the acceptability of the first approximation. Calculations revealed that the minimum height of the inversion base, which was high enough to entrap the plumes from all the stacks was 600m. Using equation (ii), the nearest downwind distance which could be considered was determined. From Figure 3-2 from Workbook of Atmospheric Dispersion Estimates, the horizontal dispersion coefficients for the given distances were found (Table VIII). The relative 10-minute average ground level concentration (X/Q) was calculated using equation (i).

As previously stated, fumigation lasts for brief periods, 15-minutes on the average (Packnett, 1973). It is generally followed by neutral (Stability Class D) or slightly unstable (Stability Class C) conditions. Therefore, the pollutant concentration for the remaining 45 minutes was assumed to occur for Stability Class C, with 2 m/sec wind speeds.

To calculate the maximum ground-level concentration (Z=0, y=0) the diffusion equation according to Turner (1970) was used.

$$(v) \quad X = \frac{Q}{\Pi \sigma_y \sigma_z u} e^{\left[-0.5\left(\frac{H}{\sigma_z}\right)^2\right]}$$

The plume rise for a buoyant plume under unstable conditions was approximated using the formula derived by Briggs.

$$(vi.a) \quad \Delta h = \frac{42A^{0.75}}{u} \quad \text{if } A \leq 24 \text{ m}^3/\text{sec}$$

or

$$(vi.b) \quad \Delta h = \frac{66.4A^{0.60}}{u} \quad \text{if } A > 24 \text{ m}^3/\text{sec}$$

where

$$A = v_s d^2 \frac{(T_s - T)}{T_s} = \text{bouyancy parameter m}^3/\text{sec}$$

The remaining terms are as previously defined.

For the conditions discussed above, the relative 10 minute average concentration (X/Q) for each source was calculated (TableIX). Adjusting the results to reflect the proper time intervals and using time-weighted averages the maximum one-hour concentration for each source was calculated using the following equation.

$$(vii) \quad X_{1\,hr} = \left(Q\frac{X_F}{Q}\right)T_{CF\,1}\left(\frac{15}{60}\right) + Q\left(\frac{X_C}{Q}\right)T_{CF2}\left(\frac{45}{60}\right)$$

where

X_{1hr} = one-hour maximum pollutant concentration (g/m^3)

Q = pollutant emission rate (g/sec)

T_{CF1} = time correction factor for converting 10-minute average concentration to 15-minute average concentration

T_{CF2} = time correction factor for converting one-hour average concentration to 45-minute average concentration

$\frac{X_F}{Q}$ = relative 10-minute average ground-level pollutant concentration during fumigation

$\frac{X_C}{Q}$ = relative 10-minute average ground-level pollutant concentration following fumigation

The contribution to the ground level concentration at the receptor site from the existing power plant in Beulah was determined using similar procedures, and the engineering data presented in Table III. It was assumed (although it is highly unlikely) that the wind direction was such that the centerlines of the plumes from all the sources the (proposed ANG stack, Basin Electric stacks and the five stacks at MDU's Beulah facility) were in line at the time fumigation occurred. The cumulative maximum estimated one-hour concentration for sulfur dioxide and nitrogen dioxide and the contribution from each source are summarized in Table IX.

Plume Trapping

As previously mentioned, under certain meteorological conditions plume trapping may occur. In this particular region it is unlikely that limited mixing would occur during extremely unstable conditions (Stability Class A) since such conditions are generally associated with strong incoming solar radiation. To insure that the plume would be trapped beneath the inversion "lid", the height of the "lid" was chosen to be just above the effective stack height. The maximum ground-level concentration resulting from plume trapping was approximated using diffusion equation according to Turner, 1970:

(viii) $$X = \frac{Q}{(2\Pi)^{0.5}\sigma y L u}$$

where L = height of the base of the inversion

The remaining terms are as previously defined.

The maximum ground-level concentration occurs at twice the distance (2x) where the plume is assumed to have a Gaussian distribution which occurs when $\sigma_z = 0.47L$. It was assumed that the worse case would occurred for Stability Class B under low wind speeds (1.0m/sec). Under these conditions the maximum effective stack height was 2425 meters. The height of the stable layer was assumed to be 2400 meters. The results are summarized in Table X.

TABLE IX: PARAMETERS FOR DETERMINING MAXIMUM ONE-HOUR GROUND LEVEL CONCENTRATION DURING AN INVERSION BREAKUP

I. Inversion Break-up:

Stability Class F
1.0 m/sec. windspeed
65°F ambient temperature
hi = 600 meters

Calculated Parameters	ANG	Basin
Predicted Plume Rise (m)	333.8	288.2
Adjusted Effective Stack Height (m)*	434.3	449.7
Distance to nearest receptor (Km)	30.0	27.8
σy (m)	730	680
σy_F (m)	784.3	736.2
$\frac{X}{Q}$ (sec/m^3)	0.848 x 10^{-6}	0.903 x 10^{-6}

II. Condition Immediately After Inversion Break-up:

Stability Class C
2.0 m/sec windspeed
65°F ambient temperature

Calculated Parameters	ANG	Basin
Predicted Plume Rise (m)	1062.4	747.0
Adjusted Effective Stack Height (m)*	1163.0	908.6
Distance to the receptor (Km)	30.0	27.8
σy_C (m)	2200.0	2050.0
σz_C (m)	1350.0	1300.0
$\frac{X}{Q}$ (sec/m^3)	0.037 x 10^{-6}	0.047 x 10^{-6}

III. Estimated Maximum One-Hour Ground-Level Concentration During An Inversion Break-up:

POLLUTANT	MAXIMUM ESTIMATED CONCENTRATION $\mu g/m^3$		
	ANG	BASIN	COMBINED
SO_2	152.8	328.5	481.3
CO	10.9	-	10.9
NO_x	32.5	136.9	169.4

* Adjusted to reflect the difference in elevation between the surrounding terrain (2000 ft.) and the plant site (1930 ft.).
H = hp + Δ h - 70' (0.3048 ft./m)

TABLE X. PARAMETER FOR DETERMINING MAXIMUM ONE-HOUR GROUND LEVEL CONCENTRATION DURING PLUME TRAPPING

Plume Trapping

Stability Class B
1.0 m/sec windspeed
65°F ambient temperature
L = 2300 meters

Calculated Parameters	ANG	BASIN
Adjusted Effective Stack Height (m)[1]	2249.8	1655.7
σ_z (m)	1081.0	
x_L (km)[2]	8.0	
$2x_L$ (km)	16.0	
σ_y (m)[2]	1800.0	
$\frac{X}{Q}$ (sec/m^3)[3]	0.096×10^{-6}	

Concentration Estimates[4]		ANG	BASIN	COMBINED
SO_2	($\mu g/m^3$)	29.6	62.6	92.2
NO_x	($\mu g/m^3$)	6.0	26.1	32.1
CO	($\mu g/m^3$)	0.7	-	0.7

(1) Adjusted to reflect the difference in elevation between the surrounding terrain and the plant site.

(2) Obtained from Figure 3-2 and 3-3, Turner's Workbook.

(3) Applicable for both proposed sources.

(4) Adjusted to reflect one hour averaging time.

2. Three-Hour Standards

Federal ambient air standards for sulfur dioxide and hydrocarbons and the significant deterioration regulations for sulfur dioxide are based on a three-hour averaging period. Using the output from the PTMAX program, the highest one-hour concentrations were determined and the concentration adjusted to reflect the proper time interval. The time correction formula supplied by the North Dakota State Health Department was used. The maximum three-hour concentration for sulfur dioxide and hydrocarbons are summarized in Table XI and Table XII respectively.

3. 24-Hour Standards

There are both Federal and State 24-hour standards for sulfur dioxide and total suspended particulates. To compute maximum the 24-hour concentration, the maximum one hour concentration occurring during slightly unstable conditions (Stability Class C) was used. The PTMAX program was used to estimate the maximum ground-level concentration attributable to stationary sources. The estimated maximum 24-hour ground level SO_2 and TSP concentration resulting from these sources are summarized in Table XIII and Table XIV, respectively. The TSP attributed to the fugitive dust emissions from the mining operations were evaluated using the procedure to evaluate area sources as described in Section C. The results of these computations are summarized in Table XV.

Annual Concentrations

There are State and Federal annual ambient air standards for sulfur dioxide, nitrogen dioxide and total suspended particulates. The annual estimates for the proposed sources were determined by multiplying the 24-hour concentration by 10%*. The maximum annual concentration resulting from the cumulative effect of the existing and proposed sources listed in Table III were determined using EPA's CDM program. The cumulative concentration from these sources at a

* The maximum persistent annual wind direction is 10% (from Bismarck 5-year averages).

TABLE XI

ESTIMATED MAXIMUM THREE-HOUR[1] SO_2 CONCENTRATION

SOURCE	MAXIMUM CONCENTRATION ($\mu g/m^3$)	STABILITY CLASS	WIND SPEED (m/sec)	DISTANCE TO THE POINT OF MAXIMUM (Km)
E010	66.1	C	15.0	3.2
E020 (A or B)	17.7	C	15.0	8.6
E201	29.7	C	15.0	2.1
E207 (3)	293.0	D	20.0	0.8
Basin (Unit #1 or #2)	127.6	C	10.0	4.1
Cumulative (2)	172.7	C	12.0	5.1

(1) The concentration derived from the PTMAX program were adjusted to reflect three-hour averaging times. The formulas supplied by the North Dakota State Health Department were used to derive the time correction factors.

(2) The cumulative effects were evaluated only at receptor sites outside of the plant boundaries. The distance given is the distance from ANG's main stack.

(3) Based on maximum emissions during upset conditions.

TABLE XII

ESTIMATED MAXIMUM THREE-HOUR(1) HYDROCARBON CONCENTRATION

SOURCE	MAXIMUM CONCENTRATION ($\mu g/m^3$)	STABILITY CLASS	WIND SPEED (m/sec)	DISTANCE TO THE POINT OF MAXIMUM (Km)
E010	4.9	D	20.0	9.6

(1) The concentration derived from the PTMAX program were adjusted to reflect three-hour averaging times. The formulas supplied by the North Dakota State Health Department were used to derive the time correction factors.

TABLE XIII

ESTIMATED MAXIMUM 24 - HOUR (1)
SO_2 CONCENTRATION

SOURCE	MAXIMUM CONCENTRATION (ug/m^3)	DISTANCE TO THE POINT OF MAXIMUM (Km)
E010	26.0	3.1
E201	11.6	2.1
E207 (4)	21.4	0.5
Basin (Both Units) (2)	50.2	4.1
Cumulative (3)	67.8	3.3

(1) The concentrations derived from the PTMAX program were adjusted to reflect 24-hour averaging time. The formulas supplied by the North Dakota State Health Department were used to derive the time correction factors.

(2) Due to the close proximity of unit 1 or unit 2 the emissions are created as being generated from on unit.

(3) The cumulative effects were evaluated only at receptor sites outside of the plant boundaries. The distance given is the distance from ANG's main stack.

(4) Based on normal operations.

TABLE XIV

ESTIMATED MAXIMUM 24 - HOUR (1) TOTAL SUSPENDED PARTICULATE CONCENTRATION

SOURCE	MAXIMUM CONCENTRATION ($\mu g/m^3$)	DISTANCE TO THE POINT OF MAXIMUM (Km)
E010	0.82	3.1
E101 (2)	15.48	0.19
E102	19.23	0.17
E103	16.31	0.20
E104	17.36	0.17
E105	8.06	0.19
E106	6.25	0.18
E107	27.50	0.19
E108	19.22	0.17
E110	7.61	0.18
E600	7.15	0.17
Basin (Both Units)	4.18	4.1
Cumulative (3)	23.60	3.3

(1) The concentration derived from the PTMAX program were adjusted to reflect 24-hour averaging times.

(2) Stack heights for sources E101-E110 were not adjusted to reflect the difference in the terrain since the distance to the point of maximum is still within the trench.

(3) The cumulative effects were evaluated only at receptor sites outside of the plant boundaries. The distance given is the distance from ANG's main stack.

TABLE XV

ESTIMATED GROUND LEVEL TSP CONCENTRATION
FROM THE MINING OPERATIONS

Distance From The Mine Site (Miles)	(Km)	Dispersion Parameters: XtX_F (1) (Km)	σz (m)	σy (m)	X/Q (sec/m^3)	Maximum 24-Hour Concentration (2) ($\mu g/m^3$)
0.5	0.8	1.3	50	130	7.0×10^{-6}	14
1.0	1.6	2.1	90	210	2.4×10^{-6}	5
1.5	2.4	2.9	130	280	1.3×10^{-6}	3
2.0	3.2	3.7	170	340	0.8×10^{-6}	2

(1) The size of the emission grid was assumed to be 15.5 acres (s=250 m), σ yo = 58.4, xy= 0.53.

(2) The estimated ground-level concentration was based on Stability Class C, 7.0 m/sec wind speeds. The emission rate from each mine site was calculated to be approximately 8.5 grams/sec. The emission rate was calculated based on an emission factor of 4.6 tons/acre, which was developed from a survey of one of Consolidated Coal's mines in Stanton. (Pedco Environmental Inc.) 16% of these emission were attributed to haul road traffic. Under ANG's mining plans a total of 500 acres/year will be initially mined at three of the four mine sites. Based on the emission factor developed from the survey, 3.4 tons/day of fugitive dust emission will be created at each mine site. To calculate the total suspended particulate emission rate it was assumed that 60% of the fugitive dust emissions are when the suspended particulate size range and that only 40% of these particles will be carried in suspension.

receptor site which coincided with the maximum estimated ground-level concentration resulting from the proposed project was determined. The meteorological input was supplied from Day/Night STAR program and the 10-year meteorological data tapes for Bismarck, North Dakota, obtained from the National Climatological Center. The input data used in CDM is summarized in Table XVI. The cumulative maximum annual sulfur dioxide, nitrogen dioxide and total suspended particulates concentrations and the contribution from the existing sources and from each proposed source are summarized in Table XVII.

Summary of Results

The maximum ground-level pollutant concentration estimates are summarized in Table XVII along with the applicable Federal and North Dakota ambient air standards.

Based upon the estimated concentrations obtained through dispersion modeling and using preliminary engineering information, it was determined that the combined project will meet all applicable North Dakota and Federal ambient air standards for sulfur dioxide, nitrogen dioxide, hydrocarbon, carbon monoxide and total suspended particulates, including significant deterioration Class II standards for sulfur dioxides and Class II for total suspended particulates.

TABLE XVI. SUMMARIZATION OF THE INPUT DATA USED IN CDM

Meteorological Data

Average afternoon mixing height	1488 meters	
Nocturnal mixing height	359 meters	
Ambient air temperature	5.67°C	
Decay Rate of SO_2	24 hours	(1)
Decay Rate of NO_2	24 hours	(1)

Source Emission Data

Data presented in Table II was used in the program, with exception of stack gas temperature which were converted to degrees centigrade.

To adequately cover the area of concern, a 60 mile by 60 mile grid, with one mile spacings was used. Since the precise locations of the existing power plants were not available at the time the calculations were performed, the following grid locations were assumed:

Plant Name	Grid Location X	Grid Location Y
Montana - Dakota Utilities, Beulah, North Dakota	13.0	19.7
Lelands Olds Power Plant Stanton, North Dakota	33.5	21.2
Milton R. Young Power Plant Center, North Dakota	38.2	49.0
United Power Association Stanton, North Dakota	32.0	20.0
Coal Creek Station Underwood, North Dakota	43.5	27.0
ANG Coal Gasification Plant, Beulah (2)	11.0	24.0

(1) The rates of decay for SO_2 and NO_2 are dependent upon meteorological factors such as temperature and relative humidity, and the presence of others gases in the atmosphere. Although the half life of SO_2 and NO_2 is frequently referenced as 3 hours and 9 hours, respectively, a 24-hour half live was chosen to simulate the "worse case" conditions.

(2) Emission data not considered in predicting cumulative impact in CDM programs.

TABLE XVII

MAXIMUM GROUND-LEVEL POLLUTANT CONCENTRATION
(All Values in Micrograms per Cubic Meter Unless Indicated)

POLLUTANT	AVERAGING PERIOD	ESTIMATED MAXIMUM CONCENTRATION (1) ANG MAIN STACK	BASIN STACKS	COMBINED PROJECT	ASSOCIATED GROWTH (3)	COMBINED IMPACT	EXISTING POINT SOURCES (3)	TOTAL	NORTH DAKOTA AMBIENT AIR STANDARDS	NATIONAL STANDARDS AMBIENT AIR PRIMARY	SECONDARY	FEDERAL & STATE DETERIORATION CLASS II
SO_2	1-hour fumigation	152.8	328.5	481.3	-	481.3	6.0	487.3	-	-	-	-
	non-inversion	108.4	209.0	283.2	4.3	287.5	2.0	289.5	715 (4)	-	-	-
	3-hour	66.1	127.6	172.7	1.1	173.8	4.0	177.8	-	-	1300(5)	700(6)
	24-hour	26.0	50.2	67.8	0.4	68.2	3.0	71.2	260 (4)	365(5)	-	100(6)
	Annual	2.4 (11)	5.2	6.7	-	6.7	2.3	9.0	60 (7)	80(7)	-	15(8)
NO_2	1-hour fumigation	32.5	136.9	169.4	-	169.4	3.0	172.4	200 (9)	-	-	-
	non-inversion	21.6	104.1	98.9	7.3	106.2	1.0	107.2	-	-	-	-
	Annual	0.5	2.1	2.9	0.7	3.6	1.5	5.1	100(7)	100(7)	100(7)	-
TSP	24-hour	0.8	4.2	23.6	2.5	26.1	8.0	34.1	150 (5)	260(5)	160(5)	30(6)
	Annual	0.1	0.4	2.4	.3	2.7	0.8	3.5	60 (10)	75(10)	60(10)	10(8)
CO (mg/m^3)	1-hour fumigation	0.1	Information not Available	0.1	-	0.1	Information not Available					-
	non-inversion	0.1		0.1	-	0.1			40 (5)	40(5)	40(5)	-
	8-hour	-		-	-	-			10 (5)	10(5)	10(5)	-
HC	3-hour	1.6			0.5	2.1			160 (5)	160(5)	160(5)	-

- Negligible

(1) Based on Briggs plume rise equations.

(2) Includes the emission from the mining area.

(3) The estimated concentration from these sources were determined at a receptor site which coincided with the maximum estimated concentration from the proposed project.

(4) Maximum concentration.

(5) Maximum concentration not to be exceeded more than once per year.

(6) Maximum allowable incremental increase.

(7) Maximum annual arithmetic mean.

(8) Maximum allowable increase over annual baseline air quality.

(9) Maximum concentrations not to be exceeded over 1% of the time in any three month period.

(10) Maximum annual geometric mean.

(11) Does not include the emissions from the shift catalyst regeneration unit, since the operation of the unit will be intermittent.

TABLE XVIII

ESTIMATED AIR EMISSION RESULTING FROM
ASSOCIATED RESIDENTIAL GROWTH

CITY	PROJECTED NUMBER OF HOUSING UNITS REQUIRED DURING PEAK EMPLOYMENT	ESTIMATED EMISSIONS FROM THE REQUIRED HOUSING (lb./hr.) SO_2	NO_2	TSP	CO	HC
Beulah	377	2.10	3.55	2.96	1.98	0.89
Hazen	354	1.97	3.34	2.78	1.39	0.83
Golden Valley	44	0.25	0.42	0.35	0.17	0.10
Pick City	11	0.06	1.08	0.09	0.45	0.54
Stanton	100	0.56	0.95	0.79	0.39	0.47
Zap	78	0.43	0.73	0.61	0.30	0.36
Center	55	0.31	0.52	0.43	0.21	0.26
Dodge	11	0.06	1.08	0.09	0.45	0.54
Halliday	78	0.43	0.73	0.61	0.30	0.36
Construction Camp	334		1.91	0.49	1.91	0.19

(1) Source Addendum B (ANR-Basin Joint Project) to the Environmental Impact Report North Dakota Gasification Project for ANG Coal Gasification Company May, 1976, page B-20.

(2) Emission rates are based on EPA Emission factors (EPA, 1970). It was assumed that the furnace for the average residential home was 110,000 BTU/hr., oil burning unit and the furnace for mobile unit in the construction camp were propane-fired, 75,000 BTU./hr. units.

E. Estimates of Ambient Air Quality Deterioration Due to Associated Growth

The ambient air quality deterioration resulting from the growth of the residential communities associated with the construction and operation of the proposed plant was estimated using the procedures , as described in Section C, to evaluate the impact of air emissions from area sources.

For the purpose of these calculations it was assumed that the majority of emissions resulting from the associated growth would come from new residential dwellings. The effect on the ambient air quality resulting from an increase in automobile traffic was assumed to be negligible, since the work force will reside in several surrounding communities and traffic to and from work will not be highly concentrated.

The predicted increase in the number of residential dwellings and their location during peak plant employment period is summarized in Table XVIII.

To evaluate the impact on the air quality the following assumptions were made.

1.) All new residential dwellings will be localized in one area of the community and each new residence (house) occupies a quarter acre lot. The size of the area grid source were computed based on this assumption.

2.) The emissions listed in Table XVIII are continuous, and uniform over the grids and

3.) The effective stack height for each dwelling is 20 feet.

All estimates of maximum ground-level concentrations were calculated for neutral stability conditions (Stability Class D) with moderate winds (7 m/sec). The results of the computations are summarized in Table XIX. As indicated in the table the impact, which is negligible, will be very localized.

TABLE XIX

ESTIMATED AMBIENT AIR QUALITY DETERIORATION DUE TO ASSOCIATED GROWTH OF THE RESIDENTIAL COMMUNITIES IN BEULAH [7]

POLLUTANT	AVERAGING PERIOD	MAXIMUM CONCENTRATION CONCENTRATION [1] I[2]	II[2]	NORTH DAKOTA AMBIENT AIR STANDARDS	NATIONAL STANDARDS AMBIENT AIR PRIMARY	SECONDARY	FEDERAL AND STATE SIGNIFICANT DETERIORATION CLASS II
SO_2 (ug/m^3)	1-hour	4.3	1.9	715 [3]	-	--	No classification
	3-hour	1.1	0.6	-	-	1300 [4]	700 [5]
	24-hour	0.4	0.2	260 [3]	365 [4]	-	100 [5]
NO_x (ug/m^3)	1-hour	7.3	3.2	200 [6]	-	-	No classification
CO (mg/m^3)	1-hour	Negligible		40 [4]	40 [4]	40 [4]	No classification
	8-hour			10 [4]	10 [4]	10 [4]	No classification
HC (ug/m^3)	3-hour (6 to 9 a.m.)	0.5	0.3	160 [4]	160 [4]	160 [4]	No classification
TSP (ug/m^3)	24-hour	0.5	0.3	150 [4]	260	150	30.0

2. One hour estimates are based on: Stability Class F; 2.0 m/sec wind speed; S=0.804 Km; σ_{Y0} = 186; χ_Y = 6.5 Km [Figure 3.2 (Turner)] and the emission rates in Table XVIII therefore:

	I	II
x (Km)	1.61	3.22
x + Xy (Km)	8.11	9.72
σ z (m)	19	27
σ y (m)	230	370
x/Q ($\frac{sec}{m3}$)	6.4×10^{-6}	15.9×10^{-6}

all other estimates are based on: Stability Class D; 7.0 m/sec wind speed S= 0.804 Km; σ_{Y0} = 186; χ_Y = 3.0 [Figure 3.2 (Turner)] and the emission rates in Table XVIII therefore:

	I	II
x (Km)	1.61	3.22
x + xy (Km)	4.61	6.22
σ z (m)	44	67
σy (m)	260	320
x/Q ($\frac{sec}{m3}$)	4.0×10^{-6}	2.1×10^{-6}

2. I. Maximum ground level concentration 1 mile downwind of the community.

II. Maximum ground level concentration 2 mile downwind of the community.

3. Maximum concentration

4. Maximum concentration not to be exceeded more than one per year.

5. Maximum allowable increase over the baseline air quality not to be exceeded more than once per year.

6. Maximum concentration not be be exceeded over 1% of the time in any three month period.

7. The air quality deterioration due to the growth of other communities listed in Table XVIII would be less.

```
      SUBROUTINE JET (HF, DELHX, HP, VS, D, TS, T, U, KST, DTHDZ)          000100
C         JET PLUME FORMULAS ACCORDING TO EPA'S 'GUIDELINES FOR AIR        000110
C         QUALITY MAINTENANCE PLANNING AND ANALYSIS'; VOL 10; 1974, P 25   000120
C                                                                          000130
C         OUTPUT VARIABLES ARE                                             000140
C         HF      EFFECTIVE STACK HEIGHT                                   000150
C                                                                          000160
C         DELHX   PLUME RISE FOR SPECIFIED STABILITY CONDITION             000170
C                                                                          000180
C         INPUT VARIABLES ARE                                              000190
C         HP      PHYSICAL STACK HEIGHT                                    000200
C         VS      STACK GAS EXIT VELOCITY                                  000210
C         D       STACK DIAMETER                                           000220
C         TS      STACK GAS EXIT TEMPERATURE                               000230
C         T       AMBIENT TEMPERATURE                                      000240
C         U       WIND SPEED                                               000250
C         KST     STABILITY CONDITION                                      000260
C         DTHDZ   POTENTIAL TEMPERATURE LAPSE RATE                         000270
C                                                                          000280
C         RISE IS USED INTERNALLY FOR THE PLUME RISE.                      000290
C                                                                          000300
      GO TO (10, 10, 10, 10, 20, 20, 20), KST                              000310
      GO TO 20                                                             000320
C     CALCULATE PLUME RISE FOR UNSTABLE AND NEUTRAL CONDITIONS.            000330
   10 DELHX = 3.0 * VS * D / U                                             000340
      GO TO 50                                                             000350
C     CALCULATE PLUME RISE FOR STABLE CONDITIONS.  IF WIND SPEEDS ARE      000360
C     LESS THAN 1 M/SEC USE FORMULA FOR LIMITING CASE OF CALM OR NEAR      000370
C     CALM CONDITIONS                                                      000380
   20 DTHDZ = 0.035                                                        000390
C         IF KST = 5 THEN DTHDZ = 0.02; IF KST = 6 THEN DTHDZ = 0.035      000391
      IF (KST .EQ. 5) DTHDZ = 0.02                                         000392
      IF (U .GT. 1.) GO TO 30                                              000393
      DELHZ = 4 * ((T * V * D) ** 2.0 / (39.2 * TS * DTHDZ)) ** 0.25       000394
      GO TO 50                                                             000410
   30 DELHX = 0.945 * ((T ** 3 * VS ** 4 * D ** 4) / (TS ** 2 * U ** 2 *   000420
     X    9.8 * DTHDZ)) ** 0.1667                                          000430
C     DETERMINE THE EFFECTIVE STACK HEIGHT                                 000440
   50 HF = DELHX + HP                                                      000450
      RETURN                                                               000460
      END                                                                  000470
```

REFERENCES

1. Briggs, G. A., 1969, Plume Rise, U.S. Atomic Energy Commission, Office of Information Services, Oak Ridge, Tennessee.

2. Chepil, U.S. 1945 "Dynamics of Wind Erosion: I Nature of the Movement of Soil by Wind", Soil Science, 60 (4).

3. Environmental Protection Agency, 1974 Compilation of Air Pollutant Emission Factors (Revised), Research Triangle Park, North Carolina.

4. Environmental Protection Agency, 1974, Guidelines for Air Quality Analysis, Volume 10: Reviewing New Stationary Sources, Research Triangle Park, North Carolina.

5. Hazen, L. P. and N. P. Woodfuff, 1973 "Particulate Loads Caused by Wind Erosion in the Great Plains". U. S. Department of Agriculture, Manhattan, Kansas. Paper presented at the 66th Annual Meeting of the Air Pollution Control Association, Chicago, Illinois, June 24-28, 1973.

6. The Northern Great Plains Resource Program Staff, 1975. The Northern Great Plains Resource Program Cooperative Resources.

7. Nordsieck, R. et al. 1976, Impact of Energy Resource Development of Reactive Air Pollutants in the Western United States, Final Report: Volume II Retail Study; Method and Results. U. S. EPA, Washington, D. C.

8. Packnett, D. S., 1973, One-Hour Fumigation Concentrations, Hayden Power Plant, Colorado. Environmental Sciences Division, Stearns-Roger Incorporated, Denver, Colorado. (Submitted to Air Pollution Control Association for publication).

9. Turner, D. B., 1970, Workbook of Atmospheric Dispersion Estimates, Office of Air Programs, Environmental Protection Agency, Research Triangle Park, North Carolina.

APPENDIX J

Written Comments on Draft Environmental Statement
and Bureau of Reclamation Responses

INDEX TO WRITTEN COMMENTS

Advisory Council on
Historic Preservation
1522 K Street N.W.
Washington, D.C. 20005

April 6, 1977

Mr. Donald D. Anderson
Acting Commissioner
Bureau of Reclamation
U. S. Department of the Interior
Washington, D. C. 20240

Dear Mr. Anderson:

This is in response to your request of March 22, 1977 for comments on the draft environmental statement for the ANG Coal Gasification Company, North Dakota. The Council has reviewed the statement and notes that the undertaking will affect numerous archeological and historical resources that may be eligible for inclusion in the National Register of Historic Places.

Pursuant to Section 106 of the National Historic Preservation Act of 1966, (16 U.S.C. 470f, as amended, 90 Stat. 1320) Federal agencies must, prior to the approval of the expenditure of any Federal funds on an undertaking or prior to the granting of any license, permit or other approval for an undertaking, afford the Council an opportunity to comment on the effect of the undertaking upon properties included in or eligible for inclusion in the National Register of Historic Places. For your convenience, a copy of the Council's "Procedures for the Protection of Historic and Cultural Properties" (36 C.F.R. Part 800) is enclosed.

Until the requirements of Section 106 are met, the Council considers the draft environmental statement to be incomplete in its treatment of historical, archeological, architectural and cultural resources. To remedy this deficiency, the Council will provide substantive comments on the undertaking's effect on the previously mentioned properties through the Section 106 process. Please contact Brit Allan Storey of the Council's Denver staff at (303) 234-4946, an FTS number, to assist you in completing this process as expeditiously as possible.

Sincerely yours,

Louis S. Wall
Assistant Director, Office
of Review and Compliance

Enclosure

The Council is an independent unit of the Executive Branch of the Federal Government charged by the Act of

J-1

125.3

United States Department of the Interior

BUREAU OF RECLAMATION
WASHINGTON, D.C. 20240

IN REPLY
REFER TO: 420

JUN 10 1977

OFFICIAL FILE COPY JUN 13 1977

INFORMATION COPY TO:

	ROUTE TO	Initials	DATE
1	203		6/10
	934		

FILE TO

Mr. Louis S. Wall
Assistant Director, Office
of Review and Compliance
Advisory Council on
Historic Preservation
1522 K Street, NW.
Washington, D.C. 20005

Dear Mr. Wall:

On May 6, 1977, the Bureau of Reclamation responded to your April 6, 1977, letter concerning the draft environmental impact statement for the ANG Coal Gasification Company, North Dakota. We informed you that the American Natural Gas Service Company and the Great Lakes Gas Transmission Company have agreed to provide the information necessary for the Bureau of Reclamation's compliance with Section 106 of the National Historic Preservation Act of 1966 (16 U.S.C. 470f, as amended, 90 Stat. 1320). Enclosed for your information is a copy of a May 26, 1977, letter from the American Natural Gas Service Company stating its intent to provide us with the necessary information for Reclamation's compliance with section 106.

Sincerely yours,

(SGD) E. F. SULLIVAN

ASSISTANT Commissioner

NOTICE
If you detach enclosures, please insert your code number 203

Enclosure

United States Department of the Interior
BUREAU OF INDIAN AFFAIRS
ABERDEEN AREA OFFICE
115 FOURTH AVENUE S.E.
ABERDEEN, SOUTH DAKOTA 57401

IN REPLY REFER TO:
Environmental
Quality

APR 13 1977

Memorandum

To: Director, Bureau of Reclamation, Washington, D. C.

From: Office of the Area Director

Subject: Draft Environmental Statement--ANG Coal Gasification Company, North Dakota Project (DES 77/11)

J-2

By memorandum dated March 25, 1977 our Central Office has referred the subject statement to us for review and comment.

Section 2.4 seems to adequately point out the concerns of the Three Affiliated Tribes on Indian water rights. There may be additional concern to Law and Order as indicated with projected influx of families.

No response necessary.

Section 3.4. It is difficult to project in-migration of Indian families for the purpose of employment. However, since the prevailing winds at times would be from the southeast, the odor and particulate affects to the reservation may be of concern. The Tribal Council is considering changing the air quality designation from Class II to Class I. At this point in time it cannot be definitely stated whether the Tribes will carry through with this change.

Section 3.4.1 discusses the possibility of emissions reaching the reservation; no odors should be detected on the reservation.

Section 8.2.2 gives a sketchy discussion on the alternative routes of the product pipeline. From this description the proposed route would probably allow the least impact to the Indian residents of the Fort Totten Reservation. Right-of-way for the Great Circle Route would be difficult, if not impossible, to obtain across the Fort Totten Reservation. It is assumed that alternative 1 would by-pass the reservation to the south, but it is difficult to estimate how far.

Alternative 1 would pass about 15 miles south of the reservation.

CONSERVE AMERICA'S ENERGY

Save Energy and You Serve America!

We have provided copies of this draft to the Tribe and our Agency office at New Town, North Dakota; we have not received their comments yet.

We appreciate the opportunity to review ano comment on your proposal.

Area Director

United States Department of the Interior

BUREAU OF OUTDOOR RECREATION
WASHINGTON, D.C. 20240

IN REPLY REFER TO:
LBR/ND
DES-77/11

MAY 4 1977

Memorandum

To: Commissioner of Reclamation

From: Acting Director, Bureau of Outdoor Recreation

Subject: Draft Environmental Statement--ANG Coal Gasification Company, North Dakota Project

We have reviewed the subject materials as requested in your memorandum of March 22, 1977, and submit the following comments.

General Comments

The information in the statement is very general. Both the maps and narrative are of such a general nature that it is difficult to determine the impact this proposal will have on recreational resources in the area.

Specific impacts to recreational resources are discussed in Section 3.3.2.7.

The following incorporated communities affected by the proposed product pipeline have projects that receive assistance from the Land and Water Conservation Fund: Beulah, Hazen, Drake, Garrison, Underwood, Cole Herbor, and Devils Lake. Information as presented in this statement is not of sufficient detail to determine the impacts this project may have on recreation resources in these communities. Park and recreation areas receiving monies from the Fund are subject (in their entirety) to the provisions of Section 6(f) of the Land and Water Conservation Fund Act of 1965, as amended. Section 6(f) permits no changes from recreational land use in a park so assisted without approval of the Secretary of the Interior. The Secretary can approve such a conversion only if it is in accord with the State Comprehensive Outdoor Recreation Plan, and then only upon the substitution of other properties of at least equal fair market value and reasonable equivalent usefulness and location. There is no provision under this section for acceptance of cash in payment for other areas.

We know of no parks which will be affected; however, if land use changes of park and recreation areas receiving Land and Water Conservation Fund monies occur, the Secretary will have to approve the changes. No impacts other than increased use of these areas are anticipated. If any parks are affected by the pipeline, the company will have to comply with provisions of Section 6(c) of the Land and Water Conservation Fund Act.

We suggest that you coordinate this project with the State liaison officers in both North Dakota and Minnesota to avoid possible conversions of parklands. Their names and addresses are as follows:

Gary Leppart, Coordinator
State Outdoor Recreation Agency
RR #2, P.O. Box 139
Mandan, North Dakota 58554

The Bureau of Reclamation has been coordinating the project with the agencies mentioned and will continue this coordination in the future.

Mike O'Donnell, Commissioner
Department of Natural Resources
301 Centennial Building
658 Ceder Street
St. Paul, Minnesota 55101

Specific Comments

Page 1-59: This section of the report indicates that with minor exceptions most of the right-of-way would use existing Burlington Northern and Soo Line Railroad right-of-way. Additional information should be provided on what the present use is of the 79 acres of new right-of-way to be acquired.

As mentioned on pages 2-57 and 3-38 of the DES, the current use of all 79 acres is agricultural.

Page 1-61: Figure 1-18 (map) should clearly delineate and identify the proposed route of the new transmission line.

Figure 1-18 has been clarified.

J-5

Page 3-47, b. Knife River, Spring Creek, and Antelope Creek: The Knife River from Hazen Riverside Park, one-half mile south of the community to the junction with the Missouri River near Stanton, has been identified in the North Dakota Statewide Comprehensive Outdoor Recreation Plan as an extensively used scenic and recreational river. The final environmental statement should be more specific as to what precautions will be taken to protect this recreational resource.

This reach of the Knife River would experience increased TDS and mineral levels as discussed in Sections 3.1.2.1 and 3.2.3 of the DES; however, these increases would be so slight that it is not possible to predictively quantify them at this time. Any significant changes in water quality would be detected through the U. S. Geological Survey's monitoring program and the State could order corrective action, thus no effects on recreation are anticipated. No special precautions other than those discussed in Section 4.2.3.3 to protect water quality are necessary to protect recreational aspects of this reach of the river.

Fred J Jones

*For Mary Lou Grier

United States Department of the Interior

GEOLOGICAL SURVEY
RESTON, VIRGINIA 22092

OFFICE OF THE DIRECTOR

In Reply Refer To:
EGS-DES-77/11
Mail Stop 760

APR 28 1977

Memorandum

To: Commissioner of Reclamation

Through: Assistant Secretary--Energy and Minerals MAY 3

From: Director, Geological Survey

Subject: Review of draft environmental statement for ANG Coal Gasification Company's North Dakota Project

J-6

We have reviewed the subject draft environmental statement as requested in your memorandum of March 22.

Page 1-23, par. 3: The statement explains that about 19 million gallons of potable water, which would be required for the mines, may come from existing wells. This seems to conflict with Mercer County permit conditions (p. 4-17, item 8) which state that ANGCGC shall neither draw nor utilize ground water from underlying or adjacent aquifers following completion of the water pipeline and commencement of water diversion from Lake Sakakawea; the apparent discrepancy should be explained.

Page 1-44, 1-45, 3-8: More information is needed on the proposed operation of the deep disposal well, especially anticipated or planned injection pressures at which 220 gallons per minute would be injected--and a statement concerning whether the 220-gpm figure represents a firm maximum. If some of the other injection wells mentioned as operating in the State utilize the same injection zone, information on their operating pressure range, history of injection, and volume range would help in impact evaluation. Also, any available information on the hydrologic characteristics of the Minnelusa Formation should be included. The statement should indicate whether any State regulations govern injection pressures or rates.

AMERICAN REVOLUTION BICENTENNIAL 1776-1976

The mining company, Coteau Properties, is an independent company unrelated to ANGCGC. The Mercer County permit stipulations apply only to ANGCGC. Coteau will obtain all the necessary permits related to mining, including those related to ground water use. If the same permit stipulation is applied to Coteau, the potable water could be obtained from the plant (as mentioned in the same paragraph).

Deep well injection potentials have been studied for ANGCGC by Woodward-Clyde Consultants. Copies of their reports can be obtained from ANGCGC, One Woodward Avenue, Detroit, Michigan 48226. The updated average 234-gpm is the expected injection rate for Phase I. Hydrologic characteristics of the Minnelusa Formation were included in Section 2.1.3.1 of the DES. The Water Supply and Pollution Control Division of the State Health Department, State Water Commission, and State Geological Survey will review injection pressures and rates before approving construction of the deep well disposal system.

Page 1-47, item a: "Stormwater from clean areas of the plant" apparently would include runoff from the dead- and live-storage coal piles. If so, effects of leachates and suspended solids on downstream waters should be discussed.

The stormwater runoff from the coal piles would be routed into the clean water retention pond. The pond would not have an outflow except if a 25-year flood event is exceeded, thus leachates and suspended solids would rarely reach downstream waters. The text has been clarified.

Page 1-47, 3-22: Details concerning the natural or constructed sealing of the retention pond should be given in the text.

Sealing would consist of an engineered clay lining if suitable clay is available or a synthetic membrane liner if suitable clay cannot be obtained.

Page 2-21, table 2-5: Estimates of flood magnitudes for drainages only larger than 10 square miles are shown. However, mining and reclamation procedures would require impoundments on drainages smaller than 10 square miles. The flood design standards of dams and spillways for these impoundments should be discussed.

The impoundments would be constructed to meet the 25-year flood criteria of the North Dakota State Engineer's Office, State Water Commission, and are covered under MESA laws. A discussion to this effect has been added to Section 1.5.5.2.

Page 3-24, par. 1 and 3: "Altered" pH and mineral content and "differences" in chemical quality are mentioned. Should these changes be considered as improvements or degradation of the quality of water?

The sentence has been clarified to point out that the pH would be lowered (a probable improvement) and mineralization increased (a probable degradation). Neither change is expected to be large enough to affect usage.

J-7

Page 3-29: Mitigation for post-gasification-plant-life and post-reclamation damage to wells should be discussed, inasmuch as North Dakota law does not protect well owners after the life of the plant. From aquifer characteristics it should be possible to anticipate the general order of magnitude of any lengthy delays in movement of pollutants. Plans for decommissioning or abandoning the facilities at the end of the project should be more fully explained.

Contrary to the assumption that North Dakota law would apply, Condition No. 14 of the Conditional Use Permit (Section 4.5.2) holds ANGCGC responsible without time limit. Presumably this contract can be enforced so long as ANGCGC is in business. Post-mining aquifer characteristics within the pit would differ from present characteristics, thus movement of pollutants cannot be predicted. Per condition No. 5 of the Conditional Use Permit the plantsite must be returned to its present condition and productivity.

Page 3-47, item a, par. 3: Runoff from the mining area would be into the Knife River basin, either naturally or by diversion. The effects on this basin from mining-area runoff are not discussed. These effects could be potentially more significant than runoff effects from the plant site and the pipeline which are discussed in items b and c.

Impacts to surface waters from mining-area runoff, including the Knife River Basin, were discussed in Section 3.1.2.1 of the DES; this section analyzes impacts to aquatic organisms from the effects on water noted in Section 3.1.2.1.

Page 4-11, sec. 4.3.2.1: Surface water is proposed to be monitored from one year prior to mining to one year after reclamation in each subbasin. One year is too short a period to obtain significant baseline or post-reclamation data in this semiarid climate. A five-year period both prior to mining and after reclamation would be more likely to yield usable data. The longer periods should be considered for at least one or possible more of the 10 subbasins. Suspended sediments should also be included in the measurements.

Details of the water monitoring program would be specified by the State Health Department and Public Service Commission who have jurisdiction in this area. The suggestion for a 5-year monitoring period has been conveyed to ANGCGC. Since mining in a subbasin would continue for several years, monitoring would continue long after reclamation of certain areas. Suspended solids has been added to the parameters to be measured.

J. K. Kelsey

Acting Director

UNITED STATES
DEPARTMENT OF THE INTERIOR
FISH AND WILDLIFE SERVICE

Area Office - North Dakota
1500 Capitol Avenue
P. O. Box 1897
Bismarck, North Dakota 58501

MAY 3 1977

MEMORANDUM

TO: Commissioner of Reclamation, Bureau of Reclamation
Washington, D.C.

FROM: Area Manager
Bismarck, North Dakota

SUBJECT: Review of Draft Environmental Statement for the ANG Coal Gasification Company, North Dakota Project

J-8

In accordance with your request of March 22, 1977, we have reviewed the draft environmental statement for the subject project. We are pleased to offer the following comments pertaining to fish and wildlife aspects for consideration in the planning activities.

General Comments

It appears that most of the biological data presented in the statement are adequate and fish and wildlife related environmental impacts have been considered. However, as pointed out in the Specific Comments section, we do not concur with all anticipated impacts as stated.

No response necessary.

The statement minimizes the potential adverse impacts to fish and wildlife from coal-fired development emissions due to the fact that quantifiable effects of stack emissions are still unknown. More attention should be given to cumulative impacts. Although adverse effects are still largely unknown, it would be inappropriate to assume that such emissions will result in anything less than significant environmental degradation.

We try to make it clear that little is known about the actual effects of emissions, but still point out potential impacts; to do otherwise would be to speculate about impacts without any supporting data. As mentioned in Section 1.4.2, the BLM-North Dakota Regional EIS will consider cumulative impacts, thus they were only briefly discussed in this EIS.

Specific Comments

1.4 Relationship to Other Projects

Under Subsection 1.4.1, page 1-12. Include Basin Electric's 212-MW (Unit I) and 440-MW (Unit II) coal-fired power generating plants and United Power Association (UPA) 172-MW coal-fired generating plant all located near Stanton, North Dakota in Mercer County.

This section was designed to discuss proposed projects. It is not necessary to discuss all of the existing projects, as any effect they have on the plantsite are already included in the baseline data. The BLM-North Dakota Regional EIS will consider the cumulative impacts of these facilities.

AMERICAN REVOLUTION BICENTENNIAL 1776-1976

UPA-CPA's two proposed 486-MW coal-fired generating plants near Falkirk, North Dakota, in McLean County, should also be included in this section.

These projects are close enough to contribute to cumulative impacts upon the region.

These proposed plants were not included because they are over 35 miles from, and the prevailing wind direction is away from, the ANGCGC site. In addition, these plants lie in the same airshed as the proposed plant, thus it was decided that any effect of these plants in the ANGCGC impact area would be minor and already included in the baseline data.

2.2.2.3 Wetland

Under Subsection Product Pipeline, page 2-65. Expressing impacted wetlands along the proposed pipeline route in terms of miles is unsatisfactory. Pipeline construction through wetlands will have an adverse effect on the entire wetland. A complete inventory of wetlands to be impacted should be undertaken revealing both the number and acres of each wetland type (as per Circular 39 USDI) affected by the product pipeline.

Data on numbers and acres of wetlands has been added. The entire wetland would seldom be affected. The ROW generally crosses only a corner of the wetland, thus cofferdams and other construction practices would be used to minimize disturbance to the entire wetland.

2.2.4.3 Product Pipeline Route

Under Subsection a. North Dakota, Paragraph 6, page 2-78. Replace number 4 with the following material:

> Devils Lake is presently the best northern pike producing water in North Dakota, as well as supporting a white bass and a walleye fishery. Because of the salinity problems, the fishery is managed on a put-and-take basis for some species.

The paragraph has been changed to reflect this comment.

J-9

2.2.5.2 Endangered Species

Paragraph 1, page 2-80. Insert the following material after the first sentence:

> In fact, two confirmed sitings are recorded for Mercer County during the fall of 1975. It is also probable that the artic peregrine falcon could be found in the region during migration.

The paragraph has been changed to reflect this comment.

3.1.1.3 Cumulative Impact on Ambient Air Quality - ANGCGC and Basin Electric

Under Subsection c. Potential Impacts of Emissions, Paragraph 5, page 3-16. Delete the last sentence and add the following material:

> Emission particulates contain numerous trace elements such as selenium, arsenic, mercury and cadmium which acting singly or together can change or damage the physical properties and biological systems of the area they impact.

We agree that these elements may be toxic, however, without studies that show that the low levels of these elements emitted by the proposed project would probably cause damage, we do not feel that such a statement is justified. The discussion of trace elements in this paragraph has been clarified.

3.2.1.2 Surface Mining

Under Subsection c. Wetland Communities, page 3-36. Delete the material and replace with the following:

> Wetland communities comprise about 50 acres of the area scheduled for mining. Wetland soils, due to their fertility and depth, would

Because of differential land subsidence, construction of impoundments to intercept runoff, and nonfilling of the last highwall cut, there is little doubt that there will be some wetland area after mining. What is not known is the degree to which vegetative and invertebrate communities will become established. We recommend that the Fish and Wildlife Service monitor the evolution of post-mining wetlands to determine their ultimate wildlife value.

almost certainly be converted to agricultural use. Even with proper grading it is not known if the final cuts in the mine area will hold water, or if soil conditions will support wetland communities. Therefore, a loss in wetland habitat is expected.

3.2.1.5 Product Pipeline

Under Subsection c. Wetlands, first paragraph, page 3-38. Add the following material after the paragraph:

> These construction practices will be followed on all wetlands impacted so as to maintain the integrity of the wetland. However, production on these wetlands would be lost for one season.

The paragraph has been revised to reflect that the construction practices would be used. A paragraph discussing production loss has been added to Section 3.2.1.5.

First paragraph, page 3-40. Last sentence. Change 22 miles to the correct acreage figure.

The correct acreage figure has been added.

3.2.1.6 Analysis of Impacts to Terrestrial Flora

Third paragraph, page 3-40. Delete last sentence and add the following material:

> Overall, the net effect of the proposed project on wetland habitat will be a permanent decrease in wetland acres as well as other short and long term impacts. Stack emission impacts on wetland vegetation could be significant.

See above response to comment on Section 3.2.1.2 on page J-9. The potential impacts of emissions on vegetation were discussed in Section 3.2.1.6 and are not expected to be major. Our review of the literature gives no reason to believe that emission impacts to wetland vegetation would be significantly different from those discussed for vegetation in general.

Table 3-16, page 3-41. The 47 acres of wetlands affected by the plantsite is not accurate. A field review of the proposed plantsite by personnel from this office revealed that a Type IV wetland of approximately 150-200 acres will be impacted.

The 47 acres was that portion of the wetland that was within the original ANGCGC plant site. A field review with FWS personnel on June 30, 1977, showed that the wetland lies outside the revised boundary of the proposed gasification plant. However, REA has informed us that about 60 acres of the wetland would be affected by the Basin Electric powerplant.

It is our opinion that a Section 404 permit will be required if significant portions of this wetland are filled. We recommend that careful consideration be given to avoid altering the wetland. The statement accurately reflects its high value to wildlife. The location in an area of few natural marshes increases its importance. There are several springs flowing into the marsh. Some water was present even during the current drought conditions.

See response to above comment.

3.2.2.2 Surface Mining

First paragraph, page 3-42. In the first sentence, change short term to long term.

This correction has been made.

3.2.2.3 Water Intake and Pipeline

First paragraph, page 3-43. Change last sentence to read as follows:

> This impact will be minimized by scheduling construction around the nesting season.

ANGCGC has indicated that construction cannot be scheduled around the nesting season; therefore, the sentence has been deleted.

3.2.2.6 Analysis of Impacts to Terrestrial Fauna

Paragraph 4, page 3-45. Replace the paragraph with the following material:

> Postmining rehabilitation efforts will undoubtedly be directed toward establishing as much agricultural land as possible. Consequently, acreages of wetlands and woodlands in the area will decrease as a result of mining, thus those animal species utilizing these habitats will also decrease.

The paragraph has been rewritten to clarify impacts on wetlands and woodlands.

Paragraph 1, page 3-46. Change the first sentence to read as follows:

> The decrease in postmining woody cover will negatively impact upland game birds by decreasing the winter carrying capacity of the area.

The paragraph has been changed to reflect this comment.

Paragraph 3, page 3-46. Delete the first sentence because an increase in wetland habitat is not expected.

We do not agree that over the long term wetland habitat would necessarily decrease. The text has been changed (p. 3-47) to indicate that postmining acreages are uncertain.

Paragraph 4, page 3-46. Delete the first sentence because an increase in wetland habitat is not expected.

See response to above comment.

Paragraph 6, page 3-46. Replace the entire paragraph with the following material:

> Endangered species could be impacted directly by the proposed project because it is located within the range of the endangered species that occur in the general region (Section 2.2.5.2).

We do not agree with this reasoning. No endangered species have been found in the vicinity of the plant-mine site during studies in the area by Woodward-Clyde and the North Dakota Game and Fish Department. The entire United States lies within the general range of one endangered species or another, thus the same statement could be said of any project in any location.

Paragraph 7, page 3-46. Replace the entire paragraph with the following material:

> Overall, the impact of the proposed project on existing animals would be of state and national importance because it is one of numerous projects continuing to rapidly convert the remaining prairie and wetland (and its associated wildlife) to other uses. Unless mined land is reclaimed specifically for wildlife values, the reclaimed land actually provides very little habitat for wildlife compared to minimal or, in some cases, no reclamation.

We believe the paragraph as written accurately reflects the state and national importance of the proposed project on existing animals.

3.2.3 Analysis of Impacts to Aquatic Ecosystems

Under Subsection a. Lake Sakakawea, Paragraph 2, page 3-47. Replace the entire paragraph with the following material:

> During operation of the water intake structure the probability of entrainment of larvae and young warmwater fish would be low when lake elevations are at or near normal levels (1,838 feet). However, during this time entrainment of young coldwater fish (rainbow trout, lake trout, whitefish, coho salmon and rainbow smelt) could

The intake area was surveyed by the North Central Reservoir Investigations Team and they did not find any larvae or young of the mentioned coldwater fish in the vicinity of the proposed intake. The paragraph has been revised to emphasize warmwater species.

J-11

be significant. Losses could also be significant for warmwater species during low water periods (1800 feet elevation or less) which might occur an average of 1 out of 8 years (74). Most adult and fingerling fish should be able to avoid the relatively low intake velocities (0.5 cfs at peak demand). Macroinvertebrates and plankton would also be subject to entrainment.

Paragraph 3, page 3-47. Add the following material at the end of the paragraph:

Runoff diversion does not solve the problem of increased siltation and mineralization but only changes its area of influence. Antelope Creek has recently been classified as a critical stream by the North Dakota Game and Fish Department because it provides excellent forage fish production, northern pike reproduction, and a moderate sport fishery near the mouth on northern pike, channel catfish, and walleye.

The material has been added to the paragraph.

Under Subsection c. Product Pipeline, Paragraph 4, page 3-48. Change the last sentence to read as follows:

Many of the potential impacts will be avoided by scheduling construction around wildlife and fishery reproductive and migration periods.

The sentence has been modified to reflect this comment.

3.6 Cumulative Impacts of Coal-Related Developments

First paragraph, page 3-79. Change the first sentence to read as follows:

This section is designed to discuss in a general way the major impacts that could accrue to the impact area from the currently proposed projects within a 50-mile radius of Beulah.

This would be more realistic because it adds an additional five coal-related developments that will definitely add to the cumulative emissions.

This section was not meant to be detailed regional analysis of the cumulative impacts of coal development. Rather it is a general discussion of cumulative impacts from coal development within a reasonable proximity to the proposed plantsite. The scope of the BLM-North Dakota Regional EIS would cover the developments you mention.

Paragraph 3, page 3-79. Adjust the total emission figures to include the five additional coal-related developments discussed in Section 1.4.1.

See response to above comment.

Add the following material between paragraphs 3 and 4:

A better understanding of emission densities can be gained from a comparison of projected North Dakota region emissions with the Kaiparowits scenario. Kaiparowits is a good example for comparison because the project was halted apparently due to its adverse environmental impacts. Those quantified impacts can now be used to measure the limit that society can reasonably be expected to endure. Kaiparowits was a proposed 3,000 megawatt generating complex in planning since 1962. The plant would have used the vast deposits of low sulfur coal in southern Utah and when fully operational, would generate electricity for 3 million customers in Arizona and southern California. The plant would have burned more than 1,000 tons of coal an hour and the environmental groups objected to the fact

The differences in the magnitude of the emissions, general climate, ecosystems, and airsheds make comparing the Kaiparowits and ANGCGC plant inappropriate. Further, we understand that the withdrawal of the Kaiparowits Project by its sponsors was based primarily upon economic concerns.

that its stacks would have spewed at least 300 tons of pollutants a day into the air. The National Park Service agreed that the plant's emissions would harm the region. The National Park Service concluded the plant's emissions would cause significant aesthetic intrusion within 60 miles of the plant and moderate adverse visual impact up to 100 miles from the plant. The emission levels that caused these concerns should be displayed and compared with the projected emissions (at least 800 tons per day) for the coal-related developments in southwestern North Dakota.

Since most of the effects of these pollutants on man, wildlife and plants are still unknown, the 800 tons of pollutants cast into the atmosphere a day should be viewed with grave concern.

About 10.8 tons rather than 800 tons of pollutants would be emitted each day by ANGCGC. Cumulative impacts of emissions will be presented in the BLM-North Dakota Regional EIS.

Paragraph 3, page 3-80. Add the following material to the paragraph:

Since coniferous plant species are the first to visibly manifest symptoms and many near-by communities contain coniferous trees, a monitoring program should be established in these communities to check effects of plant emissions.

The paragraph has been changed to recommend a monitoring program to determine the effect of emissions on prairie plants; the effects of emissions on conifers are being studied in Montana in association with the Colstrip powerplants and results from these studies would apply to North Dakota also.

J-13

4.1.2.2 Water Quality, Paragraph 1, page 4-2. Add the following material after the second sentence:

North Dakota State Water Quality Standards contain an antidegradation policy which states: "Water, whose existing quality is higher than the established standards, will be maintained at the higher quality unless it can be affirmatively demonstrated that a change in quality is justifiable to provide necessary economic or social development and will not adversely affect the stated beneficial uses of the water. All exceptions must be supported by data."

The second paragraph was changed to reflect this comment.

4.2.3 Biological Systems

Under Subsection 4.2.3.1 Terrestrial Flora, Paragraph 1, page 4-7. During reclamation much of the land currently covered by prairie would be converted to agricultural use. Therefore, our recommendation is to seed native grasses and woody plants and construct wetlands on public and company-owned lands in the mine area.

We agree that these measures would help minimize impacts and should be implemented.

The FWS Office of Biological Services is knowledgeable on developing wildlife habitat on reclaimed strip mined areas and would provide assistance in this area. This would help minimize the loss of wildlife habitat due to the project.

This offer has been conveyed to ANGCGC.

Another practice to minimize losses would be to exclude mining operations from gullies and ravines with patches of brush and trees. These areas provide critical food and shelter for wildlife. This practice would help to insure a more diverse biological community in the area during post mining periods.

It is seldom feasible to isolate small gullies and ravines from mining operations even though desirable from a wildlife habitat standpoint.

4.3.2.1 Surface Water

Paragraph 3, page 4-11. Add selenium, arsenic, and mercury to the parameters in the last sentence.

These elements have been added to the parameters.

4.3.3 Biological Systems

Paragraph 1, page 4-13. Add the following material to the paragraph:

> Wildlife populations will be monitored in nonmine areas to reveal the effects of stack emissions on wildlife.

The Bureau of Reclamation has recommended such a monitoring program to ANGCGC; however, no definite monitoring program to detect effects of stack emissions is planned by ANGCGC at this time.

5.1.2 Water

Paragraph 3, page 5-2. Change the second sentence to read as follows:

> Entrapment of fish and other aquatic organisms will occur.

The sentence has been changed to reflect this comment.

8.2.1 Plant Location Alternatives

Under Subsection b. Sites Nearer to Market Area, Paragraph 1, page 8-13. Add the following paragraph:

> One advantage of locating the gasification plant nearer the market area would be the elimination of adverse environmental effects to North Dakota caused by the plant and the product pipeline. If all coal-related developments were built close to the market area, North Dakota could continue to enjoy clean air and unrestricted visibility, which now are considered to be important environmental attributes.

This thought was expressed in Section 8.3.2.1.

Wm Ault/ath

cc:
Central Office, Washington (EC)
Regional Office, Denver (AENV)

OFFICE OF THE DIRECTOR

United States Department of the Interior

BUREAU OF MINES
2401 E STREET, NW.
WASHINGTON, D.C. 20241

May 5, 1977

DES-77/11

Memorandum

To: Commissioner of Reclamation

Through: Assistant Secretary--Energy and Minerals

From: Director, Bureau of Mines

MAY 10 1977

Subject: Draft environmental statement for ANG Coal Gasification Project, Mercer County, North Dakota

We have no major objections to the document, however, we suggest two revisions that we feel would contribute to better understanding of the project.

The document should clarify the relationship between total coal production and actual coal consumption of both the gasification plant and Basin Electric's powerplant. For example, the document indicates that the gasification plant would require 11.5 million tons per year (31,500 tpd). However, actual consumption would amount to 9.4 mtpy; the balance (2.1 mtpy as excess fines) would be utilized by the powerplant or sold. A tabulation or a simple flow diagram would do much to clarify the production-consumption picture.

Secondly, although the statement provides an appraisal of anticipated dollar loss to agricultural production consequent to installation of the project (p. 3-32), the methodology used to derive such costs is not presented. A brief description of all assumptions and the analytical approach used to account for agricultural losses would provide the necessary support for assessing the adequacy of that appraisal.

Thank you for the opportunity to review this statement.

Acting Director

J. D. Morgan

AMERICAN REVOLUTION BICENTENNIAL 1776-1976

J-15

Table 1-2 shows coal consumption of the ANGCGC and Basin Elective plants would total 14.6 million tons/year. The fact that the mine would produce 14.6 million tons/year has been added to Section 1.5.3.1.

The study was conducted by the Department of Agricultural Economics of North Dakota State University and is available from ANGCGC or that institution. Including a description of all assumptions and analytical approaches used in arriving at conclusions presented in the EIS would preclude keeping the document clear and concise as directed by Executive Order 11991. However, the general method used involved average production for the various soil types in the area times 1974 dollar values for the various crops.

United States Department of the Interior

NATIONAL PARK SERVICE
WASHINGTON, D.C. 20240

BUREAU OF RECLAMATION
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Rec'd MAY 10 1977

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IN REPLY REFER TO:

940. L7621 (RMR)PC
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MAY 9 1977

Memorandum

To: Commissioner, Bureau of Reclamation

Through: Assistant Secretary for Fish and Wildlife and Parks

From: Acting Assistant Director

Subject: Draft Environmental Statement - ANG Coal Gasification Company, North Dakota Project (DES 77-11)

J-16

As requested in your memorandum of March 22, 1977, we have reviewed the subject statement and offer the following comments.

There is no reference in this document to Knife River Indian Villages National Historic Site. The final environmental statement should identify its existence and address the impact of the proposed plant upon it. If that impact will be negative, it should so state.

Table 2-39 has been revised to delete the Buchfink site which is a component of the Knife River Indian Villages National Historic Site because these sites lie outside the area affected by the project. Section 3.4.2 has been revised to clarify the lack of impacts.

Page 2-99 presents a chart of archeological sites along the route of related developments. We note it includes an archeological site identified as Buchfink. This site which forms one of the components of Knife River Indian Villages National Historic Site is incorrectly reported as being probably destroyed.

See response to above comment.

It is unclear from the draft environmental statement whether an adequate cultural resource determination has been made concerning the effects of this project on the cultural resources of Marshall County, Minnesota. Page 2-100 identifies six sites. However, we do not know whether this determination was the result of an archeological survey or a records search. If the latter possibility is correct, we suggest that the State Historic Preservation Officer for Minnesota be contacted concerning this project. He is Mr. Russell W. Fridley, Director, Minnesota Historical Society, 690 Cedar Street, St. Paul, Minnesota 55101.

Please refer to the letters of comment received from the North Dakota State Historical Society, Minnesota Historical Society, and the Advisory Council on Historic Preservation.

We note that the draft environmental statement does not include correspondence from the respective State Historic Preservation Officers concerned. Accordingly, the final statement should include their letters of comment concerning the project. Other related correspondence such as that

Letters of comment were received from the Advisory Council on Historic Preservation (page J-79), North Dakota Historical Society (page J-96), and the Minnesota Historical Society (page J-99), and are included in the final statement.

AMERICAN REVOLUTION BICENTENNIAL 1776-1976

originated by the Advisory Council on Historic Preservation, or by the State Archeologist for either North Dakota or Minnesota, should also be included in the final statement. Such correspondence will facilitate and expedite the review process.

We are pleased to note the degree to which cultural resources have been addressed in this document. In this connection, we offer one further brief comment which relates to the protection of fragile archeological sites. Page 2-98 includes an archeological and historical resource location map. It is our view that in order to preclude unnecessary loss of the resources due to vandalism, that this map be excluded from the final statement.

Gerald D. Patten

J-17

We agree with the concern expressed for pretection of sites and have excluded certain information regarding exact locations of sites from the final statement. At a scale of 50 miles to 1 inch we believe that Figure 2-41 is not specific enough about locations to result in vandalism. Also, comments from other agencies suggest that the figure is useful (e.g. letter from the Department of the Army).

IN REPLY REFER TO:

1792 (731)

United States Department of the Interior

BUREAU OF LAND MANAGEMENT
WASHINGTON, D.C., 20240

MAY 23 1977

Memorandum

To: Commissioner, Bureau of Reclamation

From: Director, Bureau of Land Management

Subject: Review of Draft Environmental Statement, ANG Coal Gasification Company North Dakota Project

The Bureau of Land Management's (BLM) comments concerning the subject document are enclosed in two parts.

1. General Substantive Comments prepared as overview of various sections of the EIS. Inquiries concerning these comments should be addressed to Director (260), Bureau of Land Management, Washington, D. C. 20240.

2. Specific Substantive Technical comments prepared by BLM personnel assigned to the preparation of our West Central North Dakota Coal Regional Environmental Statement. Since the ANG Coal Gasification Project is a specific proposal to be discussed under the umbrella of this regional statement, we feel that these comments are very important to the overall quality of the regional document. Inquiries concerning these specific technical comments should be addressed to USDI, Bureau of Land Management, State Director, Montana, P. O. Box 30157, Billings, Montana 59107.

Our primary area of concern is the fact that the subject EIS does not cover in specific detail the issue of Federal coal connected with the ANG Project.

In order to meet the requirements of covering major Federal actions in the North Dakota Regional EIS, this issue must be more thoroughly addressed in the site-specific ANG document.

Curt Berklund

Enclosure

cc: SD, Montana

AMERICAN REVOLUTION BICENTENNIAL 1776-1976

J-18

Many of the technical comments transmitted by this letter were actually prepared by other Federal agencies and the State of North Dakota, and were sent directly to us by those agencies. For example, the comments on page 5-8 were provided by the State Health Department. Responses, therefore, are sometimes directed toward the agency originating the comment.

See response to this comment on next page.

Bureau of Land Management Comments on Draft Environmental Statement ANG Coal Gasification Company North Dakota Project

Part 1. General review comments concerning the subject DES

Chapter 1

Federal coal leasing and its relationship to other programs have not been addressed in this chapter. Page 8-9, paragraph 8.1.3.6 briefly mentions EMARS under the subtitle "Alternatives to the Proposed Mining Plan."

As originally proposed, the project would not use any Federal coal; however, now that BLM may resume leasing, Federal coal use is discussed as an alternative in Section 8.1.3.6 as agreed with BLM representatives.

Table 1-1 (p. 1-8) must include the source(s) of this data.

The source has been added to the Table 1-1.

Page 1-45. Estimates of the amount of water and chemical contaminants in this water should be provided in Table 1-16 or the text.

Figure 1-16 has been revised; chemical analysis of the raw water is presented in Appendix E.

Page 1-64. A description and locations of two compressor stations are needed. What is their power source and what efforts will be taken to mitigate pollutants and noise during their operation.

Locations of the stations are given on p. 1-64 (Miles 120 and 240). A description and the power source has been added to Section 1.5.6.1. Power would come from pipeline SNG. No special mitigation measures are proposed to reduce pollutants (Section 3.1.1.2) and the compressor would be enclosed to reduce noise.

Chapter 2

J-19

P. 2-57 and 2-58. The relationship between the vegetation types (p. 2-57) and the plant communities should be clarified.

The plant community descriptions on the following pages more fully describe the major vegetative type present at the plant-mine site.

P. 2-58. The source(s) of information leading to the conclusion that no endangered plant species were noted in the study area should be provided. Also, it must be stated whether a field survey for these plant species was conducted.

As stated in the same paragraph, a field study was conducted and the list of plant species found is shown in Appendix G; none of the plant species in Appendix G are proposed for inclusion on the list of endangered plants.

P. 2-59 (Figure 2-34). Instead of this figure showing sampling areas, a figure or figures should be provided showing the plant mine sites with the boundaries of the habitat types drawn in. This presentation should give a much clearer presentation of the relationship between the proposal and the existing environment.

This level of detail was not determined during the field study.

Pp. 2-67 through 2-80, "Wildlife." Again, the relationship between the existing wildlife resources and the proposal would be made clearer by the addition of some figures showing crucial wildlife habitats, ranges of "important" species, migration routes, etc., and project components.

We disagree with the philosophy that some species of wildlife are more important than others. Most forms of wildlife, with the exception of those with very specialized habitat requirements (e.g. waterfowl), can be found throughout the project area. Only 29 acres of scattered woodlands which might be regarded as "crucial" to some species would be affected. There are no terrestrial migration routes in the area.

P. 2-79 -- 2-80, "Endangered Species." The information presented in this section is very sketchy. One observation does not support any conclusions about the existence of the species in the area. First, sources of information must be included. Were universities and natural history museums checked for occurrence data? This section should indicate if any critical habitat of the black-footed ferret, whooping crane, etc., is found in the study area. More definite information is needed to support the impact analysis.

The section has been rewritten to reflect information provided by the U. S. Fish and Wildlife Service. As mentioned on page 2-79 no prairie dog towns (critical ferret habitat) are present in the study area and, as mentioned on page 2-80, the whooping crane only migrates through the general region.

Under "Meteorology" 2.1.2.1, the statement is made that inversions are most prevalent during the summer months; what are the summer months for this area as compared to the spring months for which inversions are lease prevalent?

June, July, and August are considered summer months; spring months would be March, April, and May.

Under "Quality" 2.1.2.2. a. Plant Mine Site. Approximately one-months' sampling of the criteria pollutants at the Plant-Mine Site appears to be considerably sparse. How can such meager data be used quantitatively and qualitatively in the impact analysis in Chapter Three on air quality as representative? What is the rationale for its use?

Passive monitoring has been conducted continuously since 1974. Because the State conducts air quality monitoring in the area, a one month program of active monitoring by ANGCGC was considered adequate. The analysis in Chapter 3 was based on 2 years of meterological data.

What are the sources for figures 2-3, 2-4, 2-5, 2-6, 2-7, 2-8, 2-8, 2-9, 2-10, 2-11, 2-12, 2-13, 2-14, 2-15, 2-16, 2-17, 2-18, 2-19, 2-20, 2-21, 2-22, 2-23, 2-24, 2-25, 2-26, 2-27, 2-28, 2-29, 2-30, 2-31, 2-32, 2-33, 2-34, 2-40 and Tables 2-6, 2-7, 2-11, 2-14, 2-16, 2-19, 2-34, 2-38, and 2-39.

As stated on page 2-1 of the DES, most of the data used in the description of the existing environment came from studies conducted by Woodward-Clyde Consultants and Ecology and Environment, Inc.; all of the figures and tables mentioned were based on data in those reports except Table 2-34. Table 2-34 was based on data provided by the North Dakota Department of Public Instruction.

Chapter 3

Vegetation/Wildlife. These sections must contain a discussion of the effects of acid rains caused by the reaction of plant air pollutants and precipitation on terrestrial and aquatic flora and fauna. A recommended source of information is Proceedings of the First International Symposium on Acid Precipitation and the Forest Ecosystems (USDA Forest Service General Technical Report NE-23, 1976).

Acid rains would not result from the emission levels of the proposed plant, thus it would be inappropriate to discuss them here. Acid rains were discussed in relation to total proposed coal development on page 3-80 of the DES and will be discussed in greater detail in the BLM-North Dakota Regional EIS.

An additional impact not addressed in the potential impacts of emissions on page 3-14 is that increment donated by the increase in the human population as a result of the proposed action. This would include housing, shopping centers and other commercial construction, auto emissions as the result of increased population, and the net increase in consumption of energy in all forms because of the project and its supportive industries.

While not singled out on page 3-14 of the DES, these impacts were considered and are detailed in Appendix I.

Wildlife

Pp. 3-38/3-40, "Wetlands." This analysis is very indefinite and provides no concrete assessment of the impacts of the proposal on this resource. Instead of an indefinite assessment like this, it would be better to present a "worst case" and most probable case analysis. The use of "ifs" and "shoulds" does not provide the reader or decisionmaker with useful information. If a conclusion about the impact cannot be made because of insufficient supporting data, this should be so stated in the environmental statement.

The section has been revised to make the assessment more definite; see also responses to Fish and Wildlife Service comments on page J-10.

P. 3-42, "Surface Mining." The impacts on terrestrial fauna described in this section are too generalized. "Those species able to tolerate nearby human activity . . . " should be identified. This section should contain an analysis of the amount of habitat lost for "important" species, the length of time for recovery, if any, and an estimate of total population losses.

During our consultation with the Fish and Wildlife Service, they indicated that the data presented were adequate. See also their letter of comment on page J-8. As to species able to tolerate human activity, we were speaking only in general terms here; specific examples would be mice, skunks, starlings, house sparrows, etc. As stated on page J-19, we consider all wildlife species important. Short-term population losses were shown in Appendix H; long-term losses would depend on how the land is reclaimed and, as stated in several places in the DES (e.g. page 3-41), that is not predictable at this time.

P. 3-44, Section f, "Endangered Species." This statement conflicts with the statement on page 2-80. It must be made clear if ANGCGC is committed to a survey for endangered or threatened species' critical habitat of the proposed pipeline route. This committment must be stated in Chapter 1 if the conclusion of "no adverse impacts" is made on p. 3-44.

The sentence has been changed to reflect this comment. The commitment by Great Lakes was stated in page 2-80 of the DES. The pipeline ROW is outside the range of all endangered species except whooping cranes, peregrine falcons, and blackfooted ferrets. It would not provide suitable habitat for any of these.

Page 3-48 (last paragraph). Table 3-14 and not Table 2-14 should be referenced here.

The citation has been corrected to Table 2-6.

Chapter 4

The narrative fails to relate what specific actions will be taken by the applicant to comply with the Historic Preservation Act of 1966 (80 Stat. 915) and Executive Order 11593, in section 4.1.4.1. entitled "Cultural Resources," Page 4-4.

Specific actions were discussed in Section 4.4.2 of the DES.

Mitigation measures applied by the applicant must be real and enforceable. The phrase "would be" should be replaced by "will be" or "shall be." The latter phrases connote a definite commitment on the part of the applicant.

The phrase "would be" makes the same commitment for a proposal still not approved. Regardless of the wording in the EIS, enforceability will be determined by statutes and permit stipulations.

J-21

The most serious weakness of Chapter 4 is its lack of quantification with respect to reduction of certain impacts by mitigation measures.

It is necessary not only to analyze the effectiveness of each measure in reducing the impact, but to quantify where possible the reduction which would occur.

The analysis in Chapter 3 already takes into account mitigation measures as they are an integral part of the plant design. Emission reductions, for example, could only be quantified in Chapter 4 by stating emissions with and without control equipment. We feel such a discussion is not necessary to the environmental analysis.

P. 4-7. The mitigation measures are so general it is impossible to adequately assess the unavoidable adverse impacts. For example, the specific sensitive habitats that would be avoided should be named. Also, the phrase " . . . unnecessary disturbance of terrestrial fauna . . . would be avoided . . . "provides no specifics on the mitigation measures to be instituted.

This description only refers to objectives proposed by ANGCGC to show their intention to minimize impacts whenever possible

P. 4-10, "Monitoring Programs." Although monitoring of air, water and biological systems are discussed, no mention is made of action to be taken if the monitoring programs indicated additional mitigation should be required.

Specific actions would depend on the nature of the problem and cannot be predicted at this time. ANGCGC has indicated that they will take the necessary corrective measures.

Chapter 5

The unavoidable adverse impacts described in this chapter should be quantified. Of course, the degree of quantification in this chapter is dependent upon the degree of quantification in Chapter 3. The data provided in Appendix H on loss of animals due to the proposed plant should be used to make conclusions in this chapter.

We have quantified the more significant impacts in Chapter 5 (e.g., land use changes, emissions, water and coal consumption, etc.). The data in Appendix H were used to draw conclusions in Chapter 3.

Part 2. Specific Technical Comments Concerning Subject DES Submitted by BLM West Central North Dakota Regional Environmental Impact Statement Team

DEVELOPMENT AND PROJECTS

Page 1-14 The table lists the water use for the following projects as:

Coyote 21,000 acre-feet/year
NGPC 17,500 acre-feet/year

The actual water use is as follows:

Coyote 11,000 acre-feet/year
NGPC 11,750 acre-feet/year

As mentioned on page 1-12, the data on Coyote is for two 440 MW units. The data for NGPC is based on their request to purchase water; they may not actually use that much, but we consider it a maximum resource requirement of the proposed project.

Page 1-15 Reference is made to mine disturbance over 25 years of about 13,000 acres. Following this statement in the text is a table (page 1-18) that shows mine acreage disturbed of 12,500.

The figure on page 1-15 has been changed to 12,500.

Page 1-27 I recognize that the manpower requirements table is showing average workforce; however, the table does not explain whether the figures are average or peak. The title should explain what the figures represent.

The word "average" has been added to the title.

J-22

The document should clarify the relationship between total coal production and actual coal consumption of both the gasification plant and Basin Electric's powerplant. For example, the document indicates that the gasification plant requires 11.5 million tons per year (31,500) tpd). However, actual consumption would amount to 9.4 mtpy; the balance (2.1 mtyp of excess fines) would be utilized by the powerplant or sold. A tabulation for a simple flow diagram would do much to clarify the production-consumption picture.

These comments originated from the Bureau of Mines, see responses on page J-15 of this appendix.

Although the EIS provides an appraisal of anticipated dollar loss to agricultural production consequent to installation of the project (p. 3-32), the methodology used to derive such costs is not presented. A brief description of all assumptions and the analytical approach used to account for agricultural losses would provide the necessary support for assessing the adequacy of that appraisal.

See response to above comment.

We understand that the question of Federal coal tracts will be addressed as soon as the information necessary for analysis is available. (See second comment under the Geology, Topography and Minerals section.)

See response to above comment.

CLIMATE AND AIR QUALITY

Sanitary wastes: On page 1-29, reference is made to a package treatment plant for sanitary wastes with the effluent to be "further polished in an oxidation pond before release." On page 1-47, reference is made again to

this package type sanitary waste treatment unit, but if there states that the effluent is to be reused in the ash handling facilities or other process areas. No mention is made of oxidation pond use or of a release of treated waters on page 1-47. If a release into a watercourse is anticipated, a Discharge Permit will be required.

The text indicates that the description on page 1-29 refers to waste treatment only during construction; the description on page 1-47 refers to waste treatment only during operation of the plant. An application for discharge during construction will be filed by ANGCGC with the State Health Department and will have to comply with Health Department requirements.

The highest volume use of the treatment plant will probably occur during the construction period. How will the effluent from the waste treatment facility be disposed of at this time as the plant will not be in operation and the waters could not be used in any plant processing?

The effluent will be handled either by portable facilities with holding tanks or by treatment in a package unit. ANGCGC will present detailed plans to the State Health Department for approval before construction.

What sanitary facilities will be provided during the construction phase which involves the package treatment waste treatment facility, waste collection lines, and other related appurtenances?

See response to above comment.

On page 2-42, it is inferred that during high flows in the Knife River and Spring Creek that increased BOD levels were the result of the release of waste waters from treatment lagoons by communities. High flows are generally the result of either snow melt or runoff from rainfall. Nonpoint sources as well as the municipal lagoons should be included as an explanation for the increased BOD levels during high flows.

The paragraph has been changed to reflect this comment.

The proposal indicates that certain wastes will be disposed of by deep well injection. Has it been determined that the geology of the proposed disposal zone is such that the quality and quantity of the proposed disposal zone is such that the quality and quantity of those wastes can be injected into the zone without operational problems? A discharge permit will be required for this method of disposal.

As mentioned on page 2-38, a feasibility study was conducted by Woodward-Clyde Consultants. A copy of the study report was provided to the North Dakota State Health Department in October 1976 by ANGCGC. The study concluded that wastes could be injected.

On page 4-12 of the statement it is noted that a regular monitoring program will be established for groundwater quality data after mining begins. The monitoring of groundwater quality, especially around the mine areas that are being used for ash and sludge disposal, should begin prior to such activities. Perimeter wells around the mine areas should be constructed and monitoring begun before the area is used for waste disposal. Also, the question of monitoring frequency, length of time monitoring is expected to be continued, and the elements of parameters of quality to be determined should be addressed.

We agree with this comment; ANGCGC and NACCO have indicated they will work with the State Health Department, the Water Commission, and the Public Service Commission to develop a satisfactory groundwater monitoring program.

Table 2-36 should be updated to reflect present conditions.

Table 2-36 has been updated.

Paragraph A of Section 1.5.4.6 Gasification Units states that "the gas escaping during the operation of the coal lock would be exhausted together with excess air by coal lock ejectors to incineration." To date, ANC has indicated that no provisions have been made for the incineration of the coal lock exhaust gas emissions as stated in this paragraph.

The paragraph has been changed to reflect that 98 percent of the gas would be collected and processed, and the remaining 2 percent would be exhausted into the atmosphere. The remaining gas cannot be safely incinerated due to the presence of coal dust and oxygen (an explosive mixture) in the gas.

Paragraph B of Section 3.1.1.2 Air Quality lists open burning of debris as a combustion source of air pollutants. Open burning of debris is not permissible under the North Dakota Air Pollution Control Regulations.

The burning of debris has been deleted.

Paragraph B of Section 3.1.1.2 Air Quality states that small quantities of SO_x and NO_x would be emitted from the venting or flaring of the process gas during start-ups or emergencies. These emissions, although small when averaged over an annual time period, may be significant when considered over a 1-hour time period.

The short-term emissions from venting and flaring were shown in Appendix I.

Paragraph B of Section 3.1.1.2 Air Quality states that "gaseous streams containing hydrocarbons (primarily from operation of the coal locks) would be incinerated." ANG, at present, does not plan to incinerate the gaseous streams from the coal locks.

The reference to coal lock gas has been omitted. See also response to comment on Paragraph A, Section 1.5.4.6 on page J-23.

Section 5.1 lists emissions from the two plants (ANG and Basin) which do not agree closely with North Dakota State Department of Health estimates. Also, emissions listed in the Pollutant Emissions and Abatement Table found on page B-7 of Appendix B differ from figures assembled by this Department. This table also does not reflect the emissions from the refuse incinerator.

Updated emissions data have been added to Section 5.1, Section 3.1.1.2, and Appendices B and I. (ANGCGC June 15, 1977).

The sulfur disposition diagram shown on page B-8 of Appendix B does not agree with the latest information submitted to the North Dakota State Department of Health by ANG (letter under date of February 17, 1977, from P. Brooks of ANG of this Department).

An updated diagram has been substituted. (ANGCGC June 15, 1977).

The information submitted in Table 1-7 does not correlate with the latest information submitted to this Department in ANG's supplemental application submitted on December 17, 1976.

An updated Table 1-7 has been substituted. (ANGCGC June 15, 1977).

Table II and Table XVI of Appendix I ANGCGC's Air Quality Dispersion Analysis does not correlate with information submitted by ANG's supplemental application on December 17, 1976.

An updated Appendix I has been substituted (ANGCGC June 15, 1977).

Information submitted as Appendix I does not include all the information submitted to the North Dakota State Department of Health. In particular, the Draft Environmental Impact Statement does not include an equation (iv) which, in information submitted to the Department, was the equation for calculating the plume rise for a buoyant plume in calm winds into stable air which ANG approximated using the formula derived by Briggs.

See response to the above comment.

Page 1-49 of the Draft Environmental Impact Statement states that the volume of the flue gas from the refuse incinerator will be approximately 60,000 standard cubic feet per hour with a particular concentration of 0.2 grains per standard cubic foot. This results in an emission rate of 1.71 pounds

per hour. The refuse incinerator is estimated to have a load of one to two tons per day which averages to between 250 and 500 pounds per hour based on an 8-hour day. At a load of 500 pounds per hour, the incinerator would be allowed to emit particulates at a rate of 1.38 pounds per hour. Therefore, the refuse incincerator under these operation conditions would not be in compliance with the North Dakota Air Pollution Control Regulations.

Page 1-52 of the Draft Environmental Impact Statement cites an efficiency of the electrostatic precipitator for the steam boilers of about 99%. In the application for a permit to construct ANG cites an efficiency for the electrostatic precipitator of about 80%.

Page 3-20 states that the maximum daytime noise standard for industrial zones in North Dakota is 80 dba. The North Dakota State Department of Health does not have such type of noise standard.

The emission values for NO_x as shown on page 3-80 for Coyote and MPC of 1.32 pounds/10^6 BTU and 3.0 pounds/10^6 BTU, respectively, are high.

Page 4-2 states that there are no New Source Performance Standards that apply to this proposed gasification plant or its steam boilers (106). This is not true.

The time periods discussed on pages 4-10 and 4-11 for the various phases of the air quality monitoring program appear to be insufficient.

Section 3.1.1.4 Odors references rather high values of "perception levels" for SO_2 and NO_2 (page 3-17). The levels referenced of 1200 ug/m3 and 7600 ug/m^3, respectively, represent the highest or least sensitive detection threshold of literature referenced to date by this Department.

The following comments from our review of the preliminary Draft Environmental Impact Statement submitted to this Department on October 1, 1976, were either not sufficiently addressed or not addressed at all by this Draft Environmental Impact Statement:

Comment 3 which stated that the size, type, and arrangement of the liquid fuel burners in the steam boilers and superheater furnaces which contribute to a low formation of NO_x, should be discussed.

Comment 8 which requested the identification of the major access roads that will be hard-surfaced and when they will be hard-surfaced in relation to construction of the plant. The Department also requested the identification of unpaved roads and right-of-way to be sprayed with water to control fugitive dust.

A letter has been sent to the State Health Department by ANGCGC stating that the specifications for the incinerator when it is ordered would be such that they would meet State air pollution criteria.

The efficiency has been changed to 80 percent.

The reference to standards has been deleted.

The values for Coyote and MPC have been updated. (Otter-Tail Power Company May 16, 1977, ANGCGC June 15, 1977).

A letter from the State Health Department regarding the applicability of the standards has been added to Appendix B. EPA has yet to establish standards for coal gasification plants.

ANGCGC has indicated they will work with the State Health Department to establish an adequate monitoring program. The time periods were presented as minimum periods.

The values listed represent concentrations that are detectable in outdoor situations. Under laboratory conditions, trained persons can detect concentrations of SO_2 and NO_2 down to 865 mg/m^3 and 230 mg/m^3, respectively. However, these lower levels would not reflect the everyday impact of the proposed project.

After consultation with the State Health Department, this information was provided to them by ANGCGC but it is too detailed for inclusion in the EIS.

As stated on page 1-29 of the DES, the main access road to the plant would be the only paved road. It would be paved prior to plant construction. All unpaved roads and rights-of-way would be sprayed with water to control fuitive dust.

Comment 13 which requested that the expected particulate emission rate from the sodium sulfate dryer to be addressed and compared to the allowable emission rate.

The flue gas from the dryer is mixed with steam boiler flue gas and treated in the electrostatic precipitator; emissions after treatment are neligible (0.79 lbs/hr).

Comment 18 which requested that the air quality effects of two product pipeline compressor stations be discussed.

The effects of the stations on air quality would be insignificant; however, a paragraph on these stations has been added to Section 3.1.1.2.

Comment 19 which requested that the air quality effects of a half-size plant (125 MM cfd) versus the full-size plant (250 MM cfd) be discussed.

The proposed project is a 250 MMcfd plant; however, the emissions of a half-size plant would be about half those of a full-sized plant.

Questions concerning these comments should be addressed to Gene Christianson, commercial number (701) 224-2348.

WATER RESOURCES

In general, the subject of water resources is fairly adequately addressed. Exceptions are, first, the lack of any information on the amount of groundwater used for stock and ranch supplies in the area to be impacted; and, second, the lack of specific details regarding the impact of the proposed action on groundwater quality.

Groundwater use was shown in Table 2-8; impacts on groundwater quality were included in Section 3.1.2.2.

J-26

Some parts do not seem hydrologically sound. For instance, it is stated with no supporting evidence that the groundwater moves up from the deep aquifers to recharge the shallower ones. Quality of water does not seem to support this idea as a concentration of sodium in the water would likely increase as it moves up through the thick clay beds. In another place, movement of water is indicated in the Beulah Trench from Lake Sakakawea toward Knife River. This is on page 2-38. A groundwater divide higher than the maximum lake level would prevent such movement (see Figure 2-23 on page 2-32). Following are detailed comments on specific items.

Although the water quality may not reflect upward migration of water, pressure differentials are such that upward seepage may occur at low rates between some aquifers. The groundwater divide is not necessarily fixed in location or elevation, but may move in response to various conditions, in particular, water levels in Lake Sakakawea. The 1865-foot elevation only refers to the top of the water at the divide; water from the Lake could move through at a lower elevation.

Chapter 1

Page 1-10 The appropriation of underground water is controlled by the North Dakota State Water Commission and the State Engineer. The State Engineer should be added to this list.

The State Engineer has been added to the list.

Page 1-12, Subject NGPL Proposals. The write-up identifies the water needs as 17,500 acre/feet annually for the Dunn Center area. This should be corrected.

See first response on page J-22 regarding page 1-14 of the DES.

Page 1-13 under the topic "Use of Natural Resources." The mine for the NGPL Project is identified as being just north of Dunn Center. I believe it should be east of Dunn Center.

The word "north" was changed to "east."

Page 1-37 and Figure 1-15 on page 1-38. The last sentence concerning gasification says "a block flow diagram of the entire process is shown in Figure 1-15." This figure does not show any ash involved.

An arrow indicating ash byproduct has been added.

Page 1-45, line 6. The parenthetical expression reads "silt and $CaCO_4$." Would this be $CaCO_3$ and $CaSO_4$?

"Ca CO_4" has been changed to "Ca CO_3."

Page 1-47 and Figure 1-16 on page 1-44. No identification is given as to the character of the sludge to be disposed into the mine.

The estimated composition of the sludge has been added.

Chapter 2

Page 2-18, Table 2-2. It seems odd that the highest flood on the Knife River near Golden Valley during a period of 60 years only has a 21-year occurrence interval. The record for Knife River at Hazen is not 1844-1963. It is 1884-1963. This implies a continuous record which probably is incorrect. Also, why does this table include data only to 1963? The last 13 years of data are also available. Maximum flood shown for the Knife River at Hazen is in 1966. This table needs revision.

Table 2-2 has been revised.

Page 2-19, Table 2-3. Was industrial water use exactly the same every year? Could this be the amount of water right rather than the amount of water used?

The value assumes the amount authorized is the amount used; the amount actually used is probably somewhat less.

Page 2-38, lines 4, 5, and 6. The statement indicates that water goes from Lake Sakakawea to the Knife River valley near Hazen through the Antelope Creek aquifer. If maximum lake elevation is 1,850 feet, water from Lake Sakakawea cannot percolate across a groundwater divide that is identified at an altitude of 1,865.8 on page 2-29 and also shown on page 2-32 in Figure 2-23.

Croft ("Ground water Resources, Mercer and Oliver Counties, North Dakota," NDGS Bulletin #56, Part III, 1973) indicates that the aquifer acts as a conduit when the lake is at maximum elevation. See also fifth response on page J-26.

Page 2-42, subject "Streams." The first paragraph should be followed by a table listing the state standards of water quality for the various types of streams. Some of the water quality criteria are indicated in subsequent paragraphs, particularly dissolved solids and color, but the others should be shown for comparisons. Also same page, the second paragraph under "streams" describes the BOD as increasing with the release of waste water from treatment lagoons along the Knife River and Spring Creek. How far did this increase persist? Also, what was the magnitude of the increase?

State water standards are readily available and are too lengthy for reproduction in the EIS (19 pages). The State Health Department attributes some of the increase to nonpoint sources. Data available on the increase was shown in Appendix E. Criteria which may be affected by the project were included.

Page 2-43, Figure 2-33. The title of this figure should be "Surface-Water Quality Sampling Locations."

The title has been changed as indicated.

Page 2-44. The first sentence below the table on groundwater qualities is ambiguous. The exceeding of standards for Lake Sakakawea and Knife River and Spring Creek is irrelevant. What would be relevant is the relationships between the dissolved solids from the various aquifers and the state water quality standards. It suggested that this sentence be removed and recast, possibly moved to page 2-39 where the topic is "Surface Waters."

The sentence was included to give an idea of the quality of the water to the nontechnical reader who may not understand all the technical data presented in Appendix E.

Chapter 3

Page 3-16. The second paragraph. The impact of sulfur dioxide and nitrogen dioxide on tobacco has no particular relevance to western North Dakota.

The relevance was indicated when it was pointed out that tobacco is considered average in its sensitivity to air pollutants.

Page 3-23, fourth paragraph, last sentence. The statement that AnFo is responsible for increased nitrate concentrations should be documented. Also, it is stated that sulfate concentrations in existing mine pit waters is 10 times that of adjacent streams. The supporting data for these statements should be added to the appendix or should be included at this point.

The supporting data was included in Appendix E.

Page 3-23, last paragraph. The first sentence which pertains to the little effect on surface waters receiving water from the pits is negated by much of the rest of the paragraph. Revision of the paragraph would involve recasting and reversal of the first sentence.

We believe the sentence is accurate; the paragraph does not deal with the transfer of water from pits to other surface waters.

Page 3-24, third paragraph. This paragraph should include a statement that the increased erosion of reclaimed land will probably be a temporary impact but that a long term degradation of chemical quality of water is possible and probable.

These impacts on water quality were discussed on pages 3-27 to 3-29 of the DES.

Page 3-27, last complete paragraph. The last sentence in this paragraph indicates that reclaimed land could not be used as a shallow groundwater source because of leachates from the buried ash and sludge. This is a major impact and should be expanded. The reclaimed land by the end of mining would include the entire mine.

The paragraph has been expanded to clarify that the reclaimed land would eventually include the entire mine.

Page 3-29, second paragraph, fourth sentence. The statement that water levels could return to premining levels or higher following reclamation is of doubtful validity. The 19 wells would not be usable after mining unless they were deepened.

It was decided that this was a logical place to briefly discuss what could be done if the wells were actually affected.

Page 3-29, same paragraph. The last two sentences concerning replacement of water supplies may belong under "Mitigation" rather than under "Impact."

Page 3-32, first paragraph under topic d, "Geological Hazards." The fact that 762 wells have been placed in operation in North Dakota since 1954 with no known earthquake problems has very little, if anything, to do with the possibility of problems caused by deep well disposal of plant wastes. Deep well injection would result in the addition of water and possibly the increase of underground pressures. The wells cited are extraction wells whose operation would be to reduce underground pressures.

The DES specifically deals with 437 injection wells (132 low pressure and 325 high pressure) rather than 762 extraction wells. The work "injection" has been added for further clarification.

Page 3-36, topic c, "Wetland Communities." The last sentence in this paragraph should be deleted as it pertains to mitigation rather than impact.

The mitigation was an integral part of ANGCGC's proposal and cannot be deleted.

Chapter 4

Page 4-2, first paragraph under "Water Quality." Federal and state standards for water quality are indicated at this point. They should be tabulated either here or in the appendix and referred to at this point.

Federal and State standards need not be duplicated in every EIS that is written; such standards are easily available to interested persons and need only to be referenced in the EIS.

Page 4-12 topic "Groundwater" first paragraph. Monitoring of groundwater should begin before mining begins, as would be done with surface water.

An adequate groundwater monitoring program will be specified by the State Health Department as a condition to the project's solid waste disposal permit.

Chapter 5

Page 5-2, last paragraph under "Water." The last sentence states that leached water from the mine pit areas may infiltrate shallow aquifers increasing TDS. What specific elements or radicals would be increased and what would be the specific impacts on usage?

Components of the leachate were detailed on pages 3-28 and 3-29 of the DES. This chapter is a summary of major impacts described in Chapter 3 and is not intended to include all details of previously described impacts.

Chapter 7

Page 7-1, topic 7.3 "Water." The state is incomplete in that it does not include the irreversible damage to groundwater within the mined and reclaimed area. Also, there is no mention in this paragraph of the irreversible damage done to the Minnelusa Formation by injection of wastes from the deep well.

The paragraph has been changed to note the loss of groundwater within the mined area; the water in the Minnelusa formation is already so salty that it is doubtful that any significant damage will result from the proposed project.

Chapter 8

Page 8-19, last sentence in the second full paragraph. The statement "underground mining generally has less environmental impact than strip-mining" should be deleted or considerably qualified. The statement as it stands is incorrect.

The word "generally" qualifies the sentence and we believe that it is correct, as underground mining does not totally disrupt the top 100-120 feet of the earth's surface.

Appendix B

Some of the arrows on the flow diagrams need to be reversed. Specifically in the Rectisol Unit diagram, gas from cooling should be one of the inputs. In the Ammonia Recovery diagram, gas liquor probably should go into the process--according to the diagram, nothing goes in.

The arrows have been corrected.

Appendix E-10

The chemical analyses of selected miscellaneous water samples appears to have a transposition of conductivity and total dissolved solids for Sample E-98.

The values do appear to be transposed, but a check of the field notes revealed identical values.

GEOLOGY, TOPOGRAPHY, AND MINERALS

Chapter 1

Page 1-20. Can the precise area that contains 1.5 billion tons of coal be delineated on a map? Is the reserve within the current stripping depth limitations of 120 feet of overburden and a stripping ratio of less than 8:1? What are technical parameters of the reserve category?

The limits of the reserve have not been accurately determined. The 1.5 billion tons is only an estimate as is the 947 million currently recoverable tons. The coal varies from 20 to 200 feet deep with a stripping ratio of 7.63.

What is the source of the coal analyses? Can it be cited?

Commercial Testing and Engineering Company of Chicago, Illinois.

This would be a good place to indicate that the proposed action does not include the Federal tracts within the proposed mining area. Also, it could be pointed out that there is in fact both a lease application and EMARS nomination for much of the Federal coal within the proposed mining area.

The possibility of mining Federal coal is discussed in Section 8.1.3.6 as agreed with BLM representatives.

Chapter 2

Table 2-13 should be explained. What scale is the intensity shown in the second column? What is the intensity shown in the fourth column? If the Modified Mercalli scale is the one used, enclosed is a copy of the description of the various scale intensities and the associated effects at each grade of intensity (enclosure 1). There are descriptions for the Richter Scale in various publications, also. A description of the various intensities would be useful to the reader.

The fact that the intensities are based on the Modified Mercalli scale and a reference have been added; the reader has also been refered to page 14 of BLM's comments (page J-32) for a description of the Modified Mercalli scale. A description of the Richter Scale can be found in standard texts on geology.

Reference - C. F. Riether, Elementary Seismology, W. H. Freeman and Co., San Fransicso and London, 1958. S. T. Algermissen "Seismic Risk Studies in the United States," Fourth World Conference in Earthquake Engineering, Chile, 1969.

See above response.

Pages 2-46 to 2-48. A physiography map would show what is being discussed. A one-page map that could be used pretty much as is can be found in the Guide to the Geology of North Dakota by John Bluemle prepared by the North Dakota Geological Survey, page 6.

The map was examined and was found to differ significantly from the discussion, thus it was not included.

Pages 2-48 to 2-53. The discussion of the physical environment should include consideration of deep salt collapse structures and their possible impact upon the gasification plant. Even though the ANG plant is to be situated near the fringe of the deep salt collapses, such collapse structures have been identified elsewhere in the Williston Basin, in some cases resulting in active subsidence of the land surface.

As discussed on page 2-53 of the DES, no deep salt collapse structures are known to occur at the plant-mine site.

Page 2-48. Perhaps a bit more discussion of the contact between the Sentinel Butte and Tongue River. Current U. S. Geological Survey usage places the contact at the top of the HT Butte coal bed. According to a report of the Knife River KCLA being prepared by Ronald Law, Conservation Division, for OPEN FILE release, the stratigraphy interval ranges from 170 to 260 feet between Beulah-Zap and HT Butte beds in the area. The thickness given is consistent with the interval shown on the cross-section, Figure 2-35, so be sure to change the figure if you change the text.

The presence of the HT bed does not affect the proposed project or its impacts because it is 170 to 260 feet below the Beulah-Zap bed and is too deep and thin to be economically mined at this time.

In Law's report, a map shows about three feet of Schoolhouse bed in about 3 square miles of Mine No. 1 and No. 3. Seems to me this should be mentioned here and in impacts as it amounts to about 10 million tons of coal that might be mined or irretrievably committed to the spoil pile.

The seam is too thin (2-3 feet thick) to be economically mined at this time, thus it would be destroyed. This impact has been added to Chapter 3.

Page 2-50, second paragraph. Do the clinker deposits have any commercial value? Do any of the materials described in the geology section have any commercial or aesthetic values?

The clinker deposits to be disturbed by the plant and mine do not have any commercial value but would be used in facility construction to the extent possible; the other materials do not occur in large enough deposits to have commercial or other values.

Chapter 3

What would earthquakes do to the plant site and pipeline if they should occur at the maximum rates shown in Table 2-13? See Modified Mercalli Intensity Scale on Page 14 of these comments.

All structures have been designed to protect the plant against the maximum probable earthquake.

Will the sand and gravel, clinkers, and other possible construction materials at the site be stockpiled, but back as part of the overburden and lost to future uses, or be made available for future use?

Sand, gravel, and clinker will be recovered and used where economically feasible.

If the Federal coal is not mined, will it be lost to future generations as an energy source? How much would be or could be lost? Would mining Federal coal make the mining more efficient? Less efficient? How much coal will be lost as a result of recovery rates?

See discussion of the Federal coal alternative in Section 8.1.3.6; mining Federal coal would be more efficient. The recovery factor for all areas is approximately 92.5 percent thus 7.5 percent of the coal mined would be lost, or about 28 million tons for the life of the project.

How much sand and gravel will be used and where will it come from? Will areas be disturbed as a result of sand and gravel excavation? Changes in topography, new roads, destruction of forage, etc., are just a few of the impacts that could occur.

Sand and gravel would be obtained from local suppliers. About 15,000 cubic yards of both sand and gravel would be required.

How much coal, oil and gas, clinker, sand and gravel could be excluded from near future or future development as a result of construction of pipelines, powerlines, plant facilities, etc.? Is subsidence of the reclaimed mined areas likely or unlikely? What would the long term effects of subsidence be?

No deposits of these resources would be excluded from future development. No subsidence other than settling of soils due to compaction is expected. The long-term effect of this subsidence would be the creation of wetlands in some areas.

If these types of questions are applicable and they cannot be answered, they should be spelled out as unknowns, at least in the impact section of the PDES.

See above responses.

Page 7-1. Additional coal lossess could occur if Federal lands within the proposed mining area are not mined.

A sentence to this effect was added to Section 7.1.

MODIFIED MERCALLI INTENSITY SCALE

The Modified Mercalli Intensity Scale describes earthquakes by their effects for twelve grades of intensity. Each grade is assigned a Roman Numeral as listed below.

I. Not felt. Marginal and long-period effects of large earthquakes.

II. Felt by persons at rest, on upper floors, or favorably placed.

III. Felt indoors. Hanging objects swing. Vibration like passing of light trucks. Duration estimated. May not be recognized as an earthquake.

IV. Hanging objects swing. Vibration like passing of heavy trucks; or sensation of a jolt like a heavy ball striking the walls. Standing motor cars rock. Windows, dishes, doors rattle. Glasses clink. Crockery clashes. In the upper range of IV, wooden walls and frames creak.

V. Felt outdoors; direction estimated. Sleepers wakened. Liquids disturbed, some spilled. Small unstable objects displaced or upset. Doors swing, close, open. Shutters, pictures move. Pendulum clocks stop, start, change rate.

VI. Felt by all. Many frightened and run outdoors. Persons walk unsteadily. Windows, dishes, glassware broken. Knick-knacks, books, etc., off shelves. Pictures off walls. Furniture moved or overturned. Weak plaster and masonry D cracked. Small bells ring (church, school). Trees, bushes shaken.

VII. Difficult to stand. Noticed by drivers of motor cars. Hanging objects quiver. Furniture broken. Damage to masonry D, including cracks. Weak chimneys broken at roof line. Fall of plaster, loose bricks, stones, tiles, cornices (also unbraced parapets and architectural ornaments - CFR). Some cracks in masonry C. Waves on ponds; water turbid with mud. Small slides and caving-in along sand or gravel banks. Large bells ring. Concrete irrigation ditches damaged.

VIII. Steering of motor cars affected. Damage to masonry C; partial collapse. Some damage to masonry B; none to masonry A. Fall of stucco and some masonry walls. Twisting, fall of chimneys, factory stacks, monuments, towers, elevated tanks. Frame houses moved on foundations if not bolted down; loose panel walls thrown out. Decayed piling broken off. Branches broken from trees. Changes in flow or temperature of springs and wells. Cracks in wet ground and on steep slopes.

J-32

No response necessary.

IX. General panic. Masonry D destroyed; masonry C heavily damaged, sometimes with complete collapse; masonry B seriously damaged. Frame structures, if not bolted, shifted off foundations. Frames racked. Serious damage to reservoirs. Underground pipes broken. Conspicuous cracks in ground. In alluviated areas, sand and mud affected, earthquake fountains, sand craters.

X. Most masonry and frame structures destroyed with their foundations. Some well-built wooden structures and bridges destroyed. Serious damage to dams, dikes, embankments. Large landslides. Water thrown on banks of canals, rivers, lakes, etc. Sand and mud shifted horizontally on beaches, and flat land. Rails bent slightly.

XI. Rails bent greatly. Underground pipelines completely out of service.

XII. Damage nearly total. Large rock masses displaced. Lines of sight and level distorted. Objects thrown into the air.

J-33

PLANTS AND SOILS

Certain elements in the draft are well done such as the comments made concerning the effects of deteriorated air quality on human, animal, and plant health as noted on pages 3-15 and -16. Certain aspects of the statement need to be strengthened. There could be more acreage figures instead of or in addition to statements delineating percentages of one type of habitat or another. Some statement as to the likelihood of reclamation on different types of vegetative communities and also what kind of management would be required to maintain the various communities in a "reclaimed" state would be desirable.

No response necessary.

We prefer percentage figures because they give the reader an immediate impression of how much a particular habitat comprises of the total habitat disturbed. Also, exact acreage figures would be subject to change as current plans change. The likelihood of reclamation of various plant communities is not well established and is currently being studied in North Dakota. Reclamation management practices are also not well established as attempts at reclamation have only recently begun in the region. The preliminary outlook is good, however. Also, we pointed out on page 3-40 that we believe much of the reclaimed land would go into crop production.

Other comments are as follows:

Chapter 2

Page 2-58, first sentence. Who were the studies conducted by and for whom?

As mentioned on page 2-1, the studies were conducted by Woodward-Clyde, Inc. for ANG.

Page 2-58. Add rye to crops grown.

Rye has been added.

Pages 2-62 to 2-64. Perhaps a one or two sentence description of each range site type would be helpful for the layman. Example, tell why an overflow site is called an overflow site.

Detailed descriptions of the sites are contained in the Woodward-Clyde EIR. They were not included in the EIS because the names of the various sites are self-descriptive and further descriptions are not necessary for the impact analysis.

Page 2-66, Plant-Mine Site. Are the prairie thickets mentioned in the first sentence also known as "woody draws" or "hardwood draws?"

No. The thickets consist of a high shrub-low tree variable composition of juneberry, choke cherry, round-leaved hawthorne, and wild plum.

Page 66, b, tree plantings. The long narrow strips referred to in the first sentence are known as shelterbelts or windbreaks.

The text has been changed to reflect this comment.

How productive are the croplands and rangelands in comparison to other similar lands in the area?

The SCS advises us that the productivity is essentially the same.

Chapter 3

Page 3-22. If woodlands can be reclaimed to their original condition more than 3-4 years would be required. Make a specific statement about the reclamation of woodlands ("woody draws").

The page numbers are apparently in error. Reclamation of woodlands was discussed on page 3-36 of the DES. We doubt if there will be any attempt to reestablish woody draws.

Page 3-22. What criteria are used to make these statements on economic losses incurred to agriculture and the AUMs that would be lost?

Average present productivity of the land that would be disturbed by the proposed project.

Page 3-36, in line 3, change may to would.

The word "may" was changed to "would."

Page 3-36, wooded communities. Cite reference for the statement "woody species can often survive directly on spoil materials."

This statement was based on personal observation by USBR personnel during field trips to the area.

Pages 3-40 and 3-41. Good comment on the loss of native prairies - also should mention reclaimed range is not as valuable for full season grazing as native range is.

We know of no study sufficient in scope to generalize about relative productivity of reclaimed and native range.

J-34

Chapter 4

How about using irrigation for the initial establishment of vegetation during the reclamation process?

Irrigation would not be necessary during years of normal precipitation, but could be used during drought years.

ANIMALS

The North Dakota Game and Fish Department, Bismarck, North Dakota and the U. S. Fish and Wildlife Service Area Office, Bismarck, North Dakota have submitted detailed comments on this draft EIS in correspondence addressed to Mr. Robert L. McPhail, Regional Director, Bureau of Reclamation, P. O. Box 2553, Billings, MT 59103 (April 26, 1977) and Commissioner, Bureau of Reclamation, Washington, D. C. (May 3, 1977), respectively. This correspondence adequately expresses the concerns of the Animals Work Group with regard to wildlife considerations.

Responses to comments from the North Dakota Game and Fish Department are included in this Appendix.

The subject of domestic animals is not adequately treated in this draft EIS. Some attempt should be made to enumerate the livestock types found in and around the project area and to assess impacts on these animals. To aid in the start of this analysis, a table showing domestic animal populations in Mercer and Oliver Counties is enclosed. There is no mention of domestic animal diseases associated with soil disturbances or possible air pollution effects on domestic animals. Information on the effects of deteriorated air quality might be found in USDA Handbook No. 380 "Air Pollutants Affecting the Performance of Domestic Animals" by R. J. Lille.

Impacts to grazing by domestic animals was discussed on page 3-32 of the DES. The table listing numbers of domestic animals county-wide is not necessary to the impact analysis. Domestic animals were included in the discussion of pollutant effects in Section 3.1.1.3 of the DES.

Domestic Animals Populations of Mercer & Oliver Counties

	CATTLE			HOGS		
County	Five Year average	1975	1976	Five Year average	1974	1975
Mercer	64,000	70,000	69,000	5,000	4,000	4,100
Oliver	38,000	42,000	40,000	6,200	5,000	6,000

	SHEEP		HORSES	CHICKENS
County	Five Year average	1975	1974	1974
Mercer	2,400	1,900	300	10,700
Oliver	2,900	2,800	300	9,300

(USDA and the State of North Dakota, 1975)

HUMAN LEISURE PURSUITS AND VALUES

AESTHETICS:

As indicated in earlier reviews, visual resource analysis is lacking. The brief discussion of topography mentions landscape modification due to mining; however, the visual impact of the gasification plant is not discussed. Impacts of the vertical plant structures, i.e., stacks with strobe lights, tanks, conveyors, cooling towers, massive buildings, etc., may be a significant contrast to the rlling landscape of the project site. A discussion of plant appearance and measures to mitigate visual impacts should be included in the final environmental impact statement.

There are numerous other existing coal production facilities within a 50-mile radius of this development. Also, the plant would be located in a valley where it would not be visible for great distances. In view of these circumstances and the fact that local people are familiar with coal conversion facilities, we feel that the visual impact of coal development activities were both self-evident and not significant.

The analysis of construction and operation noises is incomplete. The discussion of noise impacts on page 3-20 suggest that persons living from 1.5 to 5 miles from the construction site would occasionally detect construction noise but that population centers (Beulah and Zap) should not be affected. This statement may be misleading. Residents of Beulah (approximately four miles from the plant site) may experience annoying noise levels during construction, especially if construction occurs at night. Gasification plant operating noises may also prove annoying to Beulah and Zap residents. The FES should note that, although individual reactions to noise are highly variable, noise can cause annoyance, impair hearing and speech communication, interfere with sleep, impair education and learning, lower job performance, and reduce property values. Measures to mitigate noise should deal specifically with steps to avoid increased nighttime noise levels.

Beulah is approximately 7 miles from the plantsite and should not be exposed to any loud noise from the project. The impacts mentioned are associated with very loud noise far and above that which would be experienced by the residents of nearby communities.

RECREATION

Indoor recreation is still the main concern. The social impact of added population would be lessened if indoor recreation facilities and programs were adequate. As the EIS states on page 3-73 - Private entrepreneurs would likely fill some demands. Publicly funded facilities and programs are the major concern, however. ANG inventoried indoor facilities near the proposed site in 1976. Although a list of facilities would not be necessary in the EIS, a general evaluation of how well they now meet community needs should be made. How crowded are these facilities? Are towns planning to expand their facilities or programs? A few telephone calls would give authors a more accurate picture of indoor recreation needs.

These comments originated from the North Dakota Park Service; see responses on pages J-89 and J-90 of this appendix.

After school and summer use of school gymnasiums should be investigated, and suggested as a mitigating measures. A discussion of needs for public libraries was also missing from the three drafts, and should be included in the final EIS. Adequate library facilities and books would also mitigate social and recreation impacts.

See response to above comment.

The impact of added people on public hunting lands was not discussed. The North Dakota Game and Fish Department personnel anticipate upland game hunting would be most affected by the project by way of habitat loss and by increased hunting pressure. In Lake Sakakawea, walleye fishing is improving while at the same time, northern pike fishing is declining due to habitat loss. Information on man-days of outdoor recreation use is available for the last few years for Hille Game Management Area (nearest the project).

See response to above comment.

HISTORY AND PREHISTORY:

Chapter 2

Page 2-97, line 13. Teepee should be spelled tipi.

It is spelled tepee in the DES; either tepee or tipi is correct according to Webster's dictionary.

Pages 2-97, 2-101. A number of archaeological terms are used to describe many of the sites present that will possibly be in the project areas. These terms are not explained or otherwise qualified in order to give the lay reader an idea of their context or importance. Examples include campsites, earthlodge village, mount sites, and such cultural terms as the Arvilla culture, Archaic, and Blackduck focus. These terms are also not used and therefore not explained further in Chapters 3 and 4.

We acknowledge the comment related to cultural terms but feel that the lay reader interested in this aspect would have a basic understanding of these terms.

Pages 2-99, table 2-39. This table includes a list of sites with the potential of archaeological data loss if impacted. Although the sites on this table are carried through to the analysis in Chapter 3 (Impacts), they are not again mentioned in Chapter 4 (Mitigation).

Mitigation measures related to the sites along the proposed pipeline route (Table 2-39) were discussed in Section 4.4.2 of the DES.

Page 2-96, section 2.4.2. This short section contains little content on non-Indian culture. In following this section through to the analysis chapters, there are no impacts detailed in Chapter 3 nor any mitigating measures in Chapter 4.

Socioeconomic impacts were discussed in Section 3.3.2.8 of the DES; we know of no proposed mitigation measures related to the non-Indian culture per se.

Chapter 3

Page 3-78. Although this section details the fact that no direct impacts will occur to archaeological and historic sites as a result of plant construction or mining, there is no mention in indirect impacts occuring from amateur artifact collecting by construction and maintenance crews or the general population. This will probably occur.

We agree that "pot hunting" is a possibility, but since the locations of these sites are not generally known and since they are on private land not subject to unlimited trespass, it is extremely doubtful that these sites would be subject to artifact collecting because of the proposed project.

Chapter 4

Page 4-14. There is an inconsistency in the titling of the section containing archaeological and cultural treatment in this chapter. In all other chapters, this section is entitled Socio-Cultural, but in this chapter, it is entitled Cultural. This would make it hard for a lay reader to track the section from chapter to chapter.

The heading has been changed from Cultural to Sociocultural.

Pages 4-14 and 4-15. Although there are sections on Indian and non-Indian cultura in Chapter 2 and a section on Indian culture in the Impacts, Chapter 3, there is no mention of these two items in Chapter 4 or succeeding chapters.

Although socioeconomic impact and effects on archeological resources are covered and would be mitigated, we know of no proposed mitigation measures related to the maintenance of these present cultures per se.

Pages 4-14 and 4-15. The mitigation section is weak. There are no specific mentions of the mitigating measures which would be applied to sites identified in Chapter 2 and analyzed for impacts in Chapter 3. Although it is mentioned in Chapter 2 that inventories will be conducted on mine sites, railroad right-of-way, and pipeline right-of-way, these subjects are not covered in Chapter 4. The historic preservation requirements including those dealing with inventory requirements should be detailed in this chapter.

Specific mitigation measures have yet to be determined; however, the North Dakota State Historical Society is working with ANGCGC to develop mitigation programs. (See letter of comment page J-96 to J-98.) Reference to the inventory requirements outlined in Chapter 2 for the product pipeline has been added to Section 4.4.2.

Chapters 4 and 5

Natural and unique features are not present in these chapters. They were not detailed in Chapter 2 or Chapter 3.

Natural and unique features would not be affected thus mitigation is not necessary. These features were detailed in Section 2.2.5 of the DES.

Pages 5-5. This short section is very general and contains no specific coverage of the sites mentioned in earlier chapters. There would be no way for the decisonmaker to analyze which sites would still be adversely impacted following mitigating measures.

As discussed in Section 3.4.2, although several sites lie near the proposed pipeline route, we know of none which will be impacted. In the event that presently unknown sites were discovered, mitigation measures (as discussed in Section 4.4.2.) would be carried out.

Chapter 6

There is no carry through of the Indian and non-Indian cultural sections nor of the archaeological and historical sections.

Cultural concerns were discussed in Section 6.6 of the DES. A section discussing archeological and historical resources has been added to Chapter 6.

Chapter 8

There is no mention of any of the socio-cultural factors described and analyzed in the preceding chapters.

For most of the alternatives, the sociocultural effects would be similar to those described for the proposed project. Differences were highlighted in Sections 8.1.1., 8.3.2.1., and 8.4.3.2. Socio-cultural effects of the various energy alternatives have been discussed in detail in "Energy Alternatives" published by CEQ.

ECONOMIC CONDITIONS

Chapter 2

A comparison of the publication density in the eight county area with that in North Dakota and the U. S. would be helpful (1970 Census data).

Such a comparison is not necessary for the impact analysis, as its relevance is not apparent.

Bismarck Junior College is nor offering a Power Plant Technology Course. Consequently, the statement on page 2-80 that technical workers needed for operation of the gas plant may not be available in the region may be in error.

A course on powerplants would not prepare workers to operate gasification plants.

Employment by activity is available for 1975. This new information would update table 2-28. (U. S. Department of Commerce, Bureau of Economic Analysis, Regional Economic Information System)

Employment by activity tends to vary from year to year; the data in Table 2-28 is adequate, as minor differences would not affect the impact analysis.

Section 2.3.2 provides various items of significance to a discussion of the existing economic conditions in the ANG project area. However, there needs to be better organization and continuity of this section. Possibly the discussion of state and local government revenue mechanisms could be moved into its own portion of Section 2.3.3, since community services are financed through public sector revenues.

We consider the organization adequate, as state and local revenues are a measure of the economy of the region.

The reference on page 2-85 to personal income tax collections data availability should be deleted. Personal incom tax collection information for 1975, if deemed necessary, is now available from the North Dakota Tax Department.

The reference was deleted.

A new state severance tax on coal will take effect July 1, 1977 (expired June 30, 1977) which raises the base rate of the tax to $0.65/ton with an escalator of $0.01 for each full point rise in the national wholesale price index over the June 1977 index. Thus, coal mined in the first quarter of Fiscal Year 1978 (July 1-September 30, 1977) would be taxed at $0.65/ton; the rate for the second quarter would be $0.65 plus the amount the wholesale price index rose between the June and September 1977 indexes; etc.

The section on coal severance and conversion taxes has been updated.

The state coal conversion facility production tax which would apply to a gasification plant is also an important state and local revenue source and should be discussed along with the severance tax.

The coal conversion tax has been included.

Section 2.3.3 should be expanded somewhat to discuss specifically the existing capacity and capability of all facilities in those towns which would be impacted by new project related population. Also, the method of financing those services should be included so that an assessment of impacts on public revenue systems could be made in Chapter 3.

Such an analysis of just the ANGCGC proposal would be of little utility as there are four other coal-related developments proposed for the impact area that would cause additional strains. The BLM-North Dakota Regional EIS is designed to analyze the cumulative impact of all five projects during the same time period, thus the most meaningful analysis of this type should be available in that EIS.

J-38

UNITED STATES DEPARTMENT OF AGRICULTURE
RURAL ELECTRIFICATION ADMINISTRATION
WASHINGTON, D.C. 20250

MAY 2 11 24 AM '77

APR 1977

SUBJECT: ANG North Dakota Project DEIS

TO: Mr. Robert L. McPhail, Regional Director
Bureau of Reclamation
P. O. Box 2553
Federal Building
Billings, Montana 59103

160

We have reviewed the subject Draft Environmental Impact Statement and find it to be a thorough, well-written document. The following comments primarily refer to information presented which conflicts with information REA has obtained during the preparation of our DEIS on Basin Electric Power Cooperative's Antelope Valley Station. The comments are referenced by the section, page, and paragraph in which they appear in the DEIS.

(a) 1.1, 1-3, paragraph 1: We were under the impression that the railroad spur would be 13.8 miles long and would be built by ANG and Basin Electric.

ANGCGC and Basin Electric would pay Burlington Northern to do the constuction. Only 9.0 miles of new construction would be required.

(b) 1.4.1, 1-11, paragraph 3: We understand that construction on Basin Electric's second unit at Antelope Valley is scheduled to begin in November of 1980.

The date has been changed to 1980.

(c) 1.5.2, 1-15, paragraph 1: It is our understanding that the Basin Electric Antelope Valley plant site is 448 acres.

The paragraph has been revised to include this acreage.

(d) 3.1.1.2: In this section there appears to be an inconsistency in the usage of NO_x and NO_2. For example, in estimating ground-level concentrations Table 3-2 refers to NO_x while Tables 3-5 and 3-7 refer to NO_2. It should be pointed out that the Federal ambient air standards are in terms of NO_x while the North Dakota ambient air standard is in terms of NO_2. It has been estimated that of the total NO_x emitted from a fossil fuel electric generating station, 90 percent is initially in the form of NO and the remaining 10 percent is NO_2. We believe that the ambient NO_2 concentrations you have presented in Tables 3-5 and 3-7 actually represent total NO_x. The percentage of NO_x as NO_2 will have to be determined to see whether the North Dakota ambient NO_2 standard will be exceeded. We also believe that the estimated NO_2 emissions for the gasification plant and power plant presented on pages 3-6 and 3-7, respectively, actually represent total NO_x and should be so indicated.

The section has been modified to use NO_x as indicated. Both the Federal and State ambient air standards are in terms of NO_2. Although out-of-the-stack emissions are largely NO, it is oxidized to NO_2 and smaller amounts of NO_3 in the presence of ozone. Also, most current monitoring devices do not distinguish between NO, NO_2, or NO_x. For these reasons, most Federal and State agencies lump all atmospheric nitrogen measurements as NO_2.

(e) page 3-6, paragraph 4: The air quality dispersion analysis is Appendix I.

The reference has been corrected to Appendix I.

(f) page 3-6, paragraph 5: We are under the impression that the estimated SO_2 emissions from the gasification plant are 5040 lbs/hr.

The values given are normal operating emissions and do not include intermittent sources; the intermittent sources were included in Appendix I.

(g) page 3-7, paragraph 3: The following are Basin Electric's estimated emissions from the Antelope Valley station;

NO_x	4930 lbs/hr.
SO_2	11832 lbs/hr.
TSP	420 lbs/hr.

Updated emission estimates have been substituted (ANGCGC July 29, 1977).

(h) 5.2.1, 5-3: A discussion on the degree of impact of the proposed gasification plant on prime and unique farmland should be included.

A discussion of impacts to prime and unique farmland has been added to Section 3.1.3.

(i) 8.2.1, 8-11, paragraph 1: The two sites studied in the Beulah-Hazen area should be identified and described in a bit more detail. Was site 3A selected as the proposed site?

ANGCGC has requested that the exact locations of the alternative sites not be revealed, as they represent areas of possible future development (letter dated July 29, 1977). Since the environmental impacts of the alternate sites would be similar to those of the proposed site (because the environment of the general area is basically the same), we do not believe it is necessary to specify locations in the EIS. In addition, selection of any of the other locations considered by ANGCGC would not lessen any of the environmental or social impacts of the proposed project. 3A was the site selected.

Thank you for allowing us to comment on the AMG North Dakota Project DEIS. This office would like to receive a copy of the Final EIS when it becomes available.

for ROWLAND C. HAND, SR.
Director
Power Supply and Engineering
Standards Division

J-40

DEPARTMENT OF THE ARMY
OMAHA DISTRICT, CORPS OF ENGINEERS
6014 U.S. POST OFFICE AND COURTHOUSE
OMAHA, NEBRASKA 68102

MROPD-M

Mr. R. K. Higginson, Commissioner
United States Dept. of the Interior
Bureau of Reclamation
18th & C Street N.W.
Washington, D.C. 20240

J-41

Dear Mr. Higginson:

This responds to your letter notice of 22 March 1977 (your ref. 430) with which you transmitted copies of the draft EIS for the ANG Coal Gasification project for our review and comment.

We have completed our review of the draft EIS and are submitting the following comments.

A statement to the effect that some work to be accomplished under this project may cause unknown archeologic, scientific, prehistoric, or historic resources of undetermined significance to be lost should be included in the summary.

The summary is designed to discuss major, known impacts; a discussion of possible impacts to these resources is presented in Section 3.4.2. Virtually every construction project could have these impacts.

In the summary, paragraph 3; the surface water quality impacts related to mine drainage should be considered (i.e., disposal of water that is pumped from the strip mine).

Again, the exact impacts are not known, but the range of possibilities are presented in Section 3.1.2.1.

Page 1-10, Under Water Supply and Pollution Control Division; NPDES permit for disposal of mine drainage should be added.

This permit requirement has been added.

Page 1-3, paragraph 3; the term "rolled-in" should be explained.

The paranthetical term (i.e. rolled-in) is defined in the same sentence.

Page 1-24, Table 1-3; the data base for trace element analysis should be more substantial in terms of number of samples and should also be recent data.

We agree with this comment; however, the data provided gives enough of a range to allow for an analysis of impacts.

Pages 2-97 and 2-100, paragraph 2.4.3; the organization in this section is confusing. We would suggest the addition of the survey results immediately after they are mentioned. Also, instead of four listings, the "present status" could be organized as follows:

The section is already organized basically as suggested; however, the headings are not used.

MROPD-M
Mr. R. K. Higginson

1. a. Plantsite
   b. Minesite

2. a. Water system
   b. Product pipeline

Page 2-98, Figure 2-41; add a dot for "archeological sites" at the junction of the Knife and Missouri Rivers (west of Missouri and north of the Knife) for the Big Hidatsa Village National Register Site.

There was a dot at this location, but it did not reproduce well; the size of the dot has been expanded.

Page 2-99, Table 2-39; the following two additions should be inserted after the Fordville Mound Group:

Site Designation	Type	Potential Impact
Big Hidatsa Village	More than 108 earthlodges, depressions, and several fortification ditches	Major-National Register Site, High research potential
Knife River Indian Villages	5 Hidatsa Villages	Major-National Register Site, High research potential

The fact that the Knife River Indian Villages National Historic Site would not be affected by the proposed project has been added to this section. The Big Hidatsa Village is not close to the proposed route.

J-42

Page 2-100, first paragraph; there is no mention here of the Big Hidatsa Village National Register Site. It is located north of the Knife River. The Northern Pacific Railroad currently runs to the west of Stanton (south of the Knife River; 6½ miles south of the Big Hidatsa Village), and does not interfere with the National Register Site.

The Big Hidatsa Village Site is approximately 7 miles north of the proposed route and would not be affected by construction or operation of the pipeline.

Page 2-100, third paragraph; there is no mention of sites in North Dakota. If the pipeline is the same route as the railroad, mention should be made to refer to last paragraph page 2-97.

The previous three paragraphs refer rather clearly to sites in North Dakota. The fact that the pipeline parallels the railroad is mentioned throughout the EIS.

Paragraph 3.1.2.1,b. on page 3-22 states that mine drainage will be pumped out of the mine and disposed of in a number of ways. One means of disposal discussed is to simply pump the water into existing streams. Lignite coal mine drainage is usually of extremely poor quality and the discharge of such drainage into surface waters should be avoided. This impact should be discussed here.

We agree the impacts might be serious if Coteau Properties decides on this course of action; however, an NPDES would be required from the State Health Department to pump the water into existing streams. Impacts are discussed on page 3-24.

MROPD-M
Mr. R. K. Higginson

Page 3-33, paragraph 3.2.1.1.,a.; this paragraph states that 47 acres of wetland would be affected by the proposed gasification facility. The U.S. Fish and Wildlife Service has conducted a field survey and has estimated the size of this wetland to be a minimum of 200 acres. This inconsistancy should be resolved. An accurate description of this wetland should be given in Chapter 2. Also, an accurate description of the impacts on this wetland should be given in the summary and Chapters 3 and 5.

A field review with representatives of the U. S. Fish and Wildlife Service on June 30, 1977, showed that the proposed gasification plantsite would not encompass the marsh. The EIS has been changed accordingly.

Page 3-47, paragraph 2, page 4-7, paragraph 4.2.3.3., and page 5-4 paragraph 5.2.3.: consideration should be given at these points concerning the aquatic ecosystem impacts related to the discharge of mine drainage into surface waters, i.e., the introduction of hazardous materials and the possible effects on aquatic life.

The statement has been clarified to shown that the impacts discussed in these sections relate to mining also.

Page 3-78, second paragraph, eighth line; change "7" to "9" (with addition of the Big Hidatsa Village site and the Knife River Indian Villages to Table 2-39).

The paragraph has been corrected to "8."

Also, third paragraph - we suggest survey of Marshall County, Minnesota.

Please see reponses to letters of comment of the Minnesota Historical Society and the Advisory Council on Historic Preservation.

Page 4-2, paragraph 4.1.2.2; it would appear that the first sentence may be an incorrect statement. Coal mine drainage is usually of very poor quality, and if discharged into surface waters, may cause significant degredation and possibly violations of water quality standards.

The fact that several control measures have been incorporated into the design of the mine and that various State agencies will monitor the effectiveness of these measures suggests that violations of water quality would not occur under normal circumstances.

Page 4-11, paragraph 4.3.2.1, subparagraph 3; the analyses for surface water samples should also include periodic (or at least occasional) analysis of the full gamut of toxic trace elements.

Trace element analysis would be performed on periodic water samples as suggested (ANGCGC July 29, 1977).

Page 4-15, paragraph 4.4.2,a.; between end of line one and beginning of line two add the following words . . .
". . . scientific, prehistorical, historical or . . ."

The sentence has been revised to reflect this comment.

Also in paragraph b.; the words "liaison officer for historical preservation" should be changed to "Historic Preservation Officer". The wording as it stands may be confusing to field workers and may waste coordination time if they don't realize that the liaison officer is the same person (or office) as the State Historic Preservation Officer.

"liason officer for historical preservation" has been changed to "Historic Preservation Officer."

J-43

MROPD-M
Mr. R. K. Higginson

Also paragraph c. should be reworded as follows:

"Contractors are not to move their excavating equipment around the material to resume operations at a new site nor will excavation of the discovery site site resume until the State Historic Preservation Officer has determined that no cultural remains are present."

The paragraph has been reworded to continue work at sites of low cultural resource potential.

Page 5-5, paragraph 5.3.2; add the word "Unknown" as the first word of the paragraph.

The word "unknown" has been added.

Also, delete the second sentence - it's not a true statement. If the resources were professionally located and salvage excavations implemented, the data recovered would be available for future study. This in itself is a mitigative action.

The sentence has been clarified.

J-44

Page 7-2, paragraph 7.9; sentences 1 and 3 are redundant and could be combined into one sentence - such as . . . "Unknown archeological and paleontological artifacts that lie beneath the land surface which will be disturbed by the proposed project may be destroyed before they are recognized as being of historical value and could be irretrievably lost."

Sentences 1 and 3 have been rewritten in light of the above two comments.

Also, sentence 2 reviews a preservation method (avoid the sites) and a mitigation method (salvage - stipulate "professionally conducted salvage operations") and perhaps should not be included under this heading.

Sentence 2 reviews the fate of the eight known sites discussed in Section 2.4.3. We believe one sentence briefly mentioning what would become of those sites is appropriate here.

Also, the last sentence (number 4) is not a totally true statement. Unprofessional, intentional disturbance of the site precludes future study with advanced techniques and constitutes an irreversible commitment. However, preservation of the site through redesign of the project at the time of discovery or mitigation through professional archeological salvage excavations at the site provides two alternatives for data retrieval for future use. Of these two alternatives, preservation of the site for future study with advanced techniques is the most desirable.

We believe the last sentence is accurate. Even if a site is salvaged, certain aspects of that site are lost to future study with advanced techniques or new knowledge as to what to look for. In addition, salvage operations are often hurried affairs and even information that can be obtained with existing methods is irretrievably lost.

We appreciate having had the opportunity to review this draft document. We would also appreciate a copy of the final environmental statement when it becomes available.

Sincerely yours,

JOHN E. VELEHRADSKY, P.E.
Chief, Planning Division

UNITED STATES DEPARTMENT OF AGRICULTURE
FOREST SERVICE
FEDERAL BUILDING MISSOULA, MONTANA 59807

8430
APR 19 1977

USDI Bureau of Reclamation
P.O. Box 2553
Federal Office Building
316 North 26th St.
Billings, MT 59103

Gentlemen.

We have reviewed your ANG Coal Gasification Company North Dakota Project Draft Environmental Impact Statement and have some general comments on the air quality consequences of the ANGCGC - Basin Electric development.

The statement is explicit in demonstrating that National and North Dakota State standards for sulfur dioxide will not be exceeded, but points out that because of our lack of knowledge concerning long-term effects of gaseous pollutants, some damage to biota may occur. Background oxidant concentrations are rather high in North Dakota, as the Statement indicates, but possible synergistic effects of SO_2 - ozone are not mentioned. Current literature indicates that SO_2 at levels lower than air quality standards may cause damage to vegetation when acting synergistically with ozone. However, it is impossible at this time to predict the impact on biotic systems.

We agree with the possibility of SO_2-ozone synergism may be possible; however, the author of the comment knew of specific documentation and our examination of the literature did not locate any.

Recent data obtained from a field study involving controlled dosages of SO_2 to natural range vegetation showed rather significant visual effects on several species of grass at concentrations below the federal standards. This was an EPA funded study in which the University of Montana and Colorado State University were a part.

Reports of the studies were obtained and although they show a significant uptake of sulfur by range plants, no harm to the plants was demonstrated at levels below Federal standards.

The extensive development of the coal resource of the Fort Union Basin in Montana, North Dakota, and Wyoming is going to have a highly significant impact on man and his environment in that area. As the number of coal-fired steam electric power plants, coal gasification plants, and other energy conversion facilities increases, there will be a concomitant decrease in air quality, including reduced visibility, and increased acidity of precipitation. Reduced diversity of ecological systems will occur. A critical evaluation of the total expected development and

As discussed in Section 1.4.2, the BLM-North Dakota Regional EIS has been designed to cover the cumulative impacts of coal-related developments in southwestern North Dakota. We agree that such regional analyses are important; however, they are beyond the scope of this site-specific EIS.

J-45

analysis of possible impacts is in order coupled with a standard national energy policy. These are points that are not addressed by this draft EIS but should be considered in significantly more detail.

Thank you for the opportunity to review the Environmental Impact Statement.

Sincerely,

for ROBERT H. TORHEIM
Regional Forester

No response necessary.

DEPARTMENT OF STATE

Washington, D.C. 20520

BUREAU OF OCEANS AND INTERNATIONAL
ENVIRONMENTAL AND SCIENTIFIC AFFAIRS

May 5, 1977

Mr. D. D. Anderson
Acting Commissioner
Bureau of Reclamation
U.S. Department of the Interior
Washington, D.C. 20240

Dear Mr. Anderson:

J-47

Thank you for the opportunity provided by your letter of March 22, 1977, for the Department to comment upon the Draft Environmental Impact Statement regarding the ANG Coal Gasification Company, North Dakota Project.

In keeping with the spirit of the US-Canadian Boundary Waters Treaty, the United States has made a consistent effort to reduce transboundary environmental impacts of projects at or near the border. In reviewing the draft EIS we noted that a significant potential may exist for transmission of airborne pollutants to Canada from a plant of this character and magnitude in the area in which it will be constructed.

We believe that possible Canadian concern on this point should be taken into account. We therefore are providing informally a copy of the draft EIS to the Canadian authorities for any comment they may wish to make. We routinely make available to Canadian officials copies of EIS's where there may be a potential impact in Canada from a federally-sponsored or funded project in the U.S.

Sincerely,

Donald R. King

Donald R. King
Director
Office of Environmental Affairs

No response necessary.

The air quality model shows that a significant transport of air pollutants into Canada from this project should not occur, as the proposed project is approximately 116 miles from the Canadian border and the prevailing wind direction is away from the border.

No response necessary.

FEDERAL POWER COMMISSION
WASHINGTON, D.C. 20426

Commissioner
Bureau of Reclamation
United States Department of
the Interior
Washington, D.C. 20240

Dear Commissioner:

The environmental staff of the Federal Power Commission's Bureau of Natural Gas has reviewed the Bureau of Reclamation's draft environmental impact statement (DEIS) on the ANG Coal Gasification Company North Dakota Project, and offers the attached list of comments.

We hope that you will find these comments helpful and we appreciate the opportunity to work with you in the formulation of the final document.

Very truly yours,

Kenneth F. Plumb

Secretary

Attachment

cc: Bruce Blanchard
Director, Office of
Environmental Review
U.S. Department of the Interior
Washington, D.C. 20240

Mr. E. P. Denson
Bureau of Reclamation
Post Office Box 2553
Billings, Montana 59103

No response necessary.

J-48

General Comments

The Summary Page of the DEIS states that "A 40-year water service contract would be issued if the project were approved" but that "The proposed facilities would have a 25-year...life."

All subsequent environmental impact calculations are based on the latter (25-year) figure. However, since a 40-year period of operations would substantially increase the acreage mined (and the overall environmental impact), we suggest that the discrepancy between the 25-year and the 40-year figures be resolved.

The contract term would begin on the date of execution which would be before construction of the plant. Also, phased facilities are involved; the second phase may not begin until 5 years or more after the first phase. The term of the contract was designed to provide adequate leeway for the uncertainties involved. Except for the acreage mined, we do not feel the overall environmental impact would change substantially.

Page 1-15--Section 1.5 should discuss the 217 miles of 36-inch pipeline looping proposed by Great Lakes Gas Transmission Company (Great Lakes) and the 28 miles of 30-inch looping with 20,000 horsepower of additional compression facilities proposed by Michigan-Wisconsin Pipe Line Company (Michigan-Wisconsin). Since these new facilities would be necessary to transport the proposed synthetic natural gas (SNG) volumes, the environmental impact of the facilities should be discussed throughout the final environmental impact statement (FEIS). A map showing the proposed looping should be included in Section 1.5.

The pipeline looping would carry natural gas from many sources, not solely SNG. In determining the scope of the EIS, it was decided that once the SNG entered existing transmission systems and was comingled with gas from other sources that this was as far as we could reasonably trace the impacts of contracting water service to ANGCGC. Wording suggested during subsequent consultation with FPC has been added to Section 1.5.

Gasification Plant Engineering

Page 1-45--The FEIS should discuss any planned automatic safety systems designed to detect combustible gases and fires, and to initiate plant shutdown in the event of an emergency.

At this time, ANGCGC does not plan to incorporate any such automatic shutdown devices, although alarm systems would be installed. Fire protection systems are discussed in Section 1.5.4.7 of the EIS.

Page 1-48--Section 1.5.5.3 should include a separate description of the phenosolvan gas liquor separation flare. According to Table II, Appendix I, this flare would continuously emit 10 percent of the total sulfur dioxide (SO_2) effluent through a separate 120-foot tall stack. However, in Section 1.5.5.3 it is not clear that this flare is separate and continuously operated.

A description of the flare stack has been added to Section 1.5.5.3. The SO_2 emissions in Table II, Appendix I are emissions during "upset" (near emergency) conditions; under normal operations the emissions would be about one-third those indicated. Appendix I has been updated to clarify which emissions occur during plant upset.

Page 1-64--Section 1.5.6.2 should explain the rationale for placing the proposed water intake tunnel 175 feet below the reservoir bottom, as shown in Figure 1-21. An estimate of the volume of material that would be excavated in constructing the proposed water pipeline tunnel should be given. The impact of spreading the excavated material over areas of undisturbed prairie habitat should be discussed in Section 3.2.1.3.

The condition of the rock makes tunneling easier at elevation 1580 and any differences in environmental impacts are minor. We do not believe it is necessary to discuss the rationale in the EIS. A paragraph discussing the impact of spreading 10,000 yards of excavated material has been added to Section 3.2.1.3.

Appendix B--Incorrect process flow directions are indicated in the schematic flow diagrams on Pages B-1 and B-3. On Page B-1, the arrowhead from "Crude and Converted Gas From Cooling" should be reversed. On Page B-3, the arrowhead from "Gas Liquor From Phenosolvan Unit" should be reversed.

The direction of the two arrows has been changed.

Air Quality

J-50

Page 3-6--The estimated length of time that the gasification plant would require to reach the 91 percent on-line factor should be clearly stated. If the 2 to 3-day figure on Page 3-6 is such an estimate, it appears to be extremely optimistic. Failure to achieve the 91 percent on-line factor over a significant timespan would result in air quality impact more serious and of longer duration than indicated in Section 3.1.1.2.

The discussion has been revised to indicate that the 2-3 day figure applies to individual gasifiers.

Page 4-2--It states, "There are, however, no New Source Performance Standards that apply to the proposed gasification plant or its steam boilers (106)."

The New Source Performance Standards (NSPS) for fossil-fuel fired steam generators defines "fossil fuel" as "...natural gas, petroleum, coal, and any form of solid, liquid, or gaseous fuel derived from such materials for the purpose of creating useful heat." It would appear that the steam boilers and superheater furnaces fueled with liquid and/or gaseous byproducts from the gasification process would be subjected to the requirements of the NSPS, except for the lignite exemption with respect to nitrogen oxides (NO_x).

New information regarding the applicability of the standards has been added to Section 4.1.2.1 and Appendix B.

Page 4-2--The FEIS should compare the performance of coal gasification emission control systems to the performance standards soon to be proposed by the U.S. Environmental

The draft standards have been changed several times since November 1976 and will likely be modified further, thus any discussion would be meaningless. The proposed plant would meet the latest draft standards reviewed (March 1977).

Protection Agency (EPA). These standards appear in Volume I of EPA's draft entitled Standards Support and Environmental Impact Statement: Proposed Standards of Performance for Lurgi Coal Gasification Plants (November 1976).

Appendix I--Table II on Page I-4 lists NO_x emissions from the main flares and the phenosolvan gas liquor separation flare as negligible. Both units have stack temperatures of 1588.75°K, a temperature at which NO_x can form in significant quantities. Table II should include an estimate of NO_x emissions from these sources or the "negligible" emission should be substantiated.

NO_x emissions from these sources would be negligible. Substantiation has been provided to the FPC, but is not included in the EIS because of the highly detailed nature of the data.

Appendix I--The estimated 1-hour maximum concentrations listed in Tables V, VI, and VII on Pages I-16, 17, and 18, respectively, are the results of EPA's PTMAX air pollution dispersion program. The estimated plume heights for most of the meteorological conditions in these tables are large and it is noted in the PTMAX program "...that extreme caution should be used in interpreting this computation as this stability type may not exist to this height...." The appendix should qualify the accuracy of the estimates in these tables with reference to this statement.

Tables V, VI, and VII are labeled as being applicable to non-inversion conditions only. Results of dispersion analyses for severe inversion conditions were presented in Tables IX and X.

Appendix I--A procedure for calculating the maximum 1-hour pollutant concentrations for inversion breakup fumigation is presented on Pages I-20 through I-22 of Appendix I. The results of the calculations shown on Page I-23 appear to be in error which results in an underestimate of the maximum 1-hour concentration:

a) The predicted plume rise listed for inversion breakup apparently uses the high estimate for buoyant plumes under stable conditions ("Guidelines for Air Quality Maintenance Planning and Analysis, Volume 10, Reviewing New Staticnary Sources," EPA, Page 25). The use of the lower estimate, as suggested in this reference, would reduce the estimated plume rise to 211.3 and 171.5 meters for the ANG Coal Gasification (ANG) and Basin Electric Power (Basin Electric) plants, respectively. When these plume rise heights are substituted into equation (iii) on Page I-20, the nearest downwind distance to fumigation is reduced to about 13.5 kilometers (km) and 14.0 km for the two plants, respectively.

After consultation with the FPC, responses to these comments were provided to them but are not included in the EIS because of the highly technical nature of both the comment and response. The air quality modeling calculations have also been provided to the Environmental Projection Agency and the North Dakota State Health Department. The original calculations were considered correct.

See response to above comment.

b) Equation (vii) on Page I-21 incorporates time correction factors for converting 10-minute average concentrations to 15-and 45-minute averages for stability classes F and C, respectively. However, Page I-11 states that predicted concentrations for stability class C are representative of 1-hour periods and classes E and F are representative of 10-minute to 1-hour periods. It is therefore unnecessary to include the time correction factors in equation (vii).

See response to above comment.

When the above two points are corrected, the maximum 1-hour SO_2 concentrations are increased to about 410 micrograms per cubic meter ($\mu g/m^3$) for ANG and 880 $\mu g/m^3$ for Basin Electric. The combined 1-hour maximum then becomes 1,290 $\mu g/m^3$.

See response to above comment.

c) The predicted plume rises for stability class C also appear to be excessive. It is questionable if stability class C could actually exist at the large effective stack heights shown on Page I-23.

See response to above comment.

d) The use of a 15-minute fumigation period conflicts with information submitted to the FPC. In response to a staff interrogatory of April 9, 1976, ANG submitted calculations for ambient concentrations during inversion breakup fumigation. The calculations used a 30-minute fumigation period as opposed to the 15-minute period suggested in Appendix I. Substituting a 30-minute fumigation period into equation (vii) would nearly double the 1-hour concentrations shown in the preceeding paragraph.

See response to above comment.

Tables 3-5 and 3-7 should reflect the corrected calculations for inversion breakup fumigation, and increase the 1-hour maximum SO_2 and NO_2 concentrations accordingly. Correcting points a) and b) above is sufficient to result in estimated ambient concentrations greater than those permitted by the North Dakota ambient air quality standards.

See response to above comment.

Water Quality

Page 1-47--It indicates that all process areas and other sources of contaminated liquids would be paved with concrete, and that drainage from these areas would be collected and treated. Conversely, runoff from clean areas on the plant site would be collected, diverted, and discharged into the natural drainage system. In which category are the coal storage piles included? Investigation 1/ indicates that leachate concentrations from the "dead storage" pile would stabilize once contaminants are flushed out, assuming the pile remains in an inactive mode. However, one would assume that leachate concentrations from the "live storage" pile would continue at relatively high levels as this pile is replenished throughout the life of the plant.

Runoff from the coal storage piles would be routed into the clean water retention pond. Page 1-47 has been changed to clarify that there would not be any discharge from the clean water retention pond into the natural drainage system.

Page 1-47--It indicates that sludge generated in the multieffect evaporator would be buried in the mine. The FEIS should indicate the composition of this sludge and determine what impact it could have on surface and ground water quality.

The composition of the sludge has been added to Section 1.5.5.2; potential impacts of leachates from ash and sludge buried in the mine were discussed in Section 3.1.2.2 of the DES.

Page 2-35--Figure 2-25 should indicate the water levels in the test wells described.

The water levels were not determined during the field study.

Page 2-43--The abbreviation should identify "Pt-Co" used in the discussion of color as representing the "platinum-cobalt" scale.

"Platinum-cobalt scale" has been added in parenthesis.

Reclamation and Biology

Page 2-15--It would be helpful if Figures 2-13, 2-37, and others of a similar type indicated the outlines of the proposed mining areas.

The entire mine area could not be put on these figures because of their scale. The mine areas are shown on a number of other figures and we believe that the reader should be able to judge where the mines are located in relation to the plantsite, which is common to all Figures.

1/ Anderson, W.C. and M.P. Youngstrom. "Coal Pile Leachate - Quantity and Quality Characteristics," Journal of the Environmental Engineering Division, ASCE (Dec. 1976), pp. 1239-1253.

Page 2-48--The DEIS states, "The most striking physiographic features near the plant-mine site are the Beulah Trench and its western extension, the Zap Trench." If these topographic features would be altered either by mining or by haul road construction, this point should be brought out in the discussion.

The features as geologic formations would not be changed by the proposed project.

Does the cover illustration represent the topography which would surround the proposed plant? If so, this cover would provide a more useful illustration of the proposed gasification plant's aesthetic impact if the direction of view and the visible topographic features, roadways, and streams were identified in the FEIS.

No; it is simply an artists representation of a typical gasification plant.

Page 3-31--The DEIS states, "After reclamation the land would be returned to its existing use or altered for a different use at the option of the landowner (who retains surface ownership unless he sells it to the company)." Has the company acquired any surface rights in the project area? If surface rights are acquired, what type of reclamation would the company choose for such lands?

NACCO has acquired surface rights to about 5 percent of the mine area. These areas would be reclaimed for uses that landowners would not normally request, specifically wildlife habitat and wetlands.

J-54

Page 3-33--It states that the time required to reestablish nonagricultural plant communities on mined lands or to return them to productive agricultural use is not known, but assumes 3 to 5 years for cropland and 10 years for rangeland. Some basis for these assumptions should be included for evaluation in the FEIS. Also, the question of whether reclaimed rangelands are as agriculturally productive as the existing natural prairie should be addressed.

The times were largely based upon results of studies of the reclamation potential of lands in the Northern Great Plains; these studies have been referenced. The question of comparative productivity has not been studied in sufficient scope to draw generalized conclusions.

Page 3-37--The DEIS states, "If soils are concentrated for agricultural use, the areas left without much topsoil can be made useful by development of woody stands for wildlife habitat." However, Page 3-41 states that "tree plantings in North Dakota almost never reproduce naturally; thus tree plantings provide only partial mitigation for the loss of native woodlands." If the tree plantings are unable to reproduce and therefore unable to sustain woodland habitat, it is difficult to see how they would provide any mitigation against the loss of native woodlands. Also, if topsoil is concentrated for agricultural use, thereby leaving some lands in a less productive condition, it is unclear how the State Water Permit Condition #8 (Page 4-16) would be met: "Mined or disturbed lands shall be returned to at least the level of agricultural productivity that existed prior to mining or disturbance."

Planting would re-establish woodlands relatively rapidly. Although the plantings would eventually die out, we believe native woodlands re-establish themselves before this occurred. Topsoil would be spread as needed for reclamation. The statement "concentrated for agricultural use" was intended to mean that some areas might have less topsoil than before and tree plantings here would be beneficial. Also, the permit condition was written prior to current reclamation law which allows landowner discretion. The condition may have to be rewritten before the final permit is issued to conform with the reclamation laws.

Page 4-8--Section 4.2.4 refers to numerous studies on reclamation conducted by governmental, university, and mining groups, but fails to cite specific studies. These studies should be referenced in the bibliography. Land areas near the proposed project site which have already undergone, or are currently undergoing reclamation efforts should be described in Section 3 (Description of the Existing Environment) of the FEIS.

No information from these studies other than their existence is included in the discussion, thus it is not appropriate to cite them in the bibliography. As stated on page 4-9 of the DES, reclamation is currently going on at NACCO's Indian Head mine 10 miles from the project area; this is generally outside the area described in Chapter 2.

Page 4-9--The DEIS states that $1,500 in performance bonds per mined acre would be committed to the reclamation effort. Would the $1,500 per acre amount be sufficient to compensate for possible future inflation? Some discussion should be provided to substantiate whether $1,500 per acre would be adequate to accomplish reclamation based on presently available knowledge and techniques.

In addition to the performance bond, mining permits are only valid for 3 years and the mining company must comply with reclamation regulations to receive a new permit. These factors should also insure that reclamation is accomplished. The $1,500/acre bond alone is currently adequate in most cases; the State legislature can raise the bond if necessary in the future.

Socioeconomics

J-55

Page 2-80--The DEIS states, "In 1970, about 14,500 workers in relevant job categories lived within 75 miles of the plant-mine site." The term "relevant job categories" should be defined. The inclusion of the larger cities of Bismark and Mandan within the data collection area tends to obscure the rural character of the communities and lands within reasonable commuting distance of the project site.

"Relevant job categories" includes those skills required at the plant or so closely related so that a worker could readily change to a required skill. The larger cities were included because a number of workers will likely be drawn from these cities which are within what is considered an acceptable commuting distance in the region.

Page 2-86--The discussion concerning the coal severance tax raises two unanswered questions: What is the total amount of money which has been raised from the tax, and how do present coal mining volumes in North Dakota compare with the new volumes which would be achieved if the proposed project is developed? On Page 3-75 of the DEIS it states that the monies which have been made available from the present coal severance tax and from other sources would not be sufficient to substantially reduce the adverse socioeconomic impact of energy development. An estimate of how much money would be needed to substantially alleviate the impact of energy development would be helpful.

The discussion has been rewritten in light of recent changes in the severance tax. Total taxes collected in the State and mining volumes are not necessary to the impact analysis; what is important is how much money is reaching the counties to be impacted and this was discussed in Section 3.3.2.8. We did not analyze how much money would be needed because four other coal-related developments are proposed for the area and the BLM-North Dakota Regional EIS is designed to determine the economic needs considering all five proposed projects.

Page 3-59--Job opportunities created by the project could lead to a shortage of farm workers in the project area, making farms more difficult to operate, and possibly causing temporary

losses in agricultural production in the affected counties. The response of farm managers to this situation could be to reduce labor requirements through greater investment in new machinery and more capital-intensive production techniques. Accordingly, the number of farm labor job opportunities could be permanently reduced. This would be a long-term impact on the socioeconomic character of the rural communities beyond that which is anticipated from the simple addition of a new industrial sector to the local economy.

Since dryland wheat and hay farming are already highly mechanized forms of agriculture, the farm labor force in the area is already very small. It seems doubtful that farmers would invest large sums of money in additional machinery because of an anticipated 2-3 year shortage in available labor.

Page 3-70--Traffic increases and their attendant environmental impact should be given more emphasis in the FEIS. Increased traffic congestion, higher accident frequencies, and possible degradation of air quality could be among the most noticeable changes affecting local communities during project development. In addition to direct and indirect employment-related traffic, job seekers and even tourists could contribute to a significant increase in traffic. Auto insurance and fuel prices could become locally inflated.

Traffic increases were discussed in Section 3.3.2.6 and increased auto accidents in Section 3.3.2.3 of the DES. Air pollution from vehicles would not be significant in this generally windy area.

Page 4-18--Would the proposed construction workcamp be built early in the project construction phase in order to provide housing during the peak period of population influx presently scheduled to occur in 1978? This peak growth period occurs several years before the actual peak population period.

The construction camp would be built to accommodate the peak influx, now scheduled for 1980. The camp would be constructed in 1978 and would be dismantled after construction of both phases of the gasification plant.

Product Pipeline

Page 1-18--The land requirements of the proposed product pipeline are given as 2,190 acres. Does this figure include the land areas that would be disturbed by the construction of the five communication towers, two compressor stations, and the district headquarters mentioned in Section 1.5.6.1? A detailed physical description of all appurtenant pipeline facilities including land requirements, compressor horsepower, and communication tower dimensions, should be provided in Section 1.5.6.1. The environmental impact associated with the construction and operation of these appurtenant pipeline facilities should be addressed in all appropriate sections of the FEIS.

The figure did not include the 32 acres required for these facilities and has been corrected. The air quality impact of the compressor stations has been added to Section 3.1.1.2; other impacts are included in the general discussion of impacts of the product pipeline. See also response #4 on page J-19.

Page 1-59--All locations where the pipeline might deviate from the railroad right-of-way should be discussed, with attention given to specific details of land use and ownership, vegetation, topography, and impact mitigation measures.

The three known areas of pipeline deviation from railroad ROW were shown in Figure 1-18 of the DES, and the land use (privately owned agriculture) of the 79 acres of the new ROW was discussed in Section 3.2.1.5. The general discussions on vegetation (Section 2.2.2), topography (Section 2.1.4.1), and mitigation (Chapter 4) apply to these 79 acres also.

Page 1-63--Procedures used to restore the right-of-way after pipeline construction should be outlined.

These procedures were illustrated in Figure 1-19 of the DES to supplement the discussion on page 1-63.

Page 1-70--A full description of right-of-way maintenance procedures should be inserted in Section 1.5.6.1, including a statement as to whether herbicides would be used. The impact of pipeline maintenance practices on flora, fauna, and the aquatic environment should be discussed in the appropriate sections of the FEIS.

The railroad companies would continue to maintain the ROW as they presently do with no special changes due to the proposed project. Maintenance activities by Great Lakes would include aircraft patrol, maintenance of signs, maintenance of facilities, etc.

Page 2-39--The reference to Lake Agassiz is confusing until the reader proceeds to Page 2-47 and finds that the lake is extinct. A detailed description of the pipeline geology, topography, and physiography should precede any other mention of potholes, Lake Agassiz, or other unusual or unqiue physiographic features.

The word "extinct" has been inserted before "Lake Agassiz."

J-57

Page 2-56--Referring to Table 2-14, it is suggested that pipeline milepost numbers be used throughout the FEIS to designate locations along the proposed pipeline route. A key map showing the milepost locations should be provided.

Since the final alignment is not set, exact milepost locations are not known; the location of features in relation to the pipeline is not necessary to understanding environmental impacts. Since the text and references are not based on a milepost system, a key map would be of little value.

Page 2-57--Land uses along the proposed pipeline right-of-way should be more fully identified, including descriptions of any national, state, and local forests, parks, and other managed areas.

Land uses along the proposed pipeline route were discussed in Section 2.2.5.1 of the DES. Other than the wildlife areas discussed in Section 2.2.5.1, no forests, parks, or other managed areas would be affected.

Page 2-61--Section 2.2.2.1(d) should describe the specific vegetational communities found on the railroad right-of-way, and should discuss their value as wildlife habitat.

The vegetational communities along the right-of-way are described in Section 2.2.2.1(d); wildlife values are discussed in Section 2.2.2.3.

Page 2-65--The FEIS should include a map and describe in detail the major plant communities which would be traversed by the proposed SNG pipeline. Particular emphasis should be given to the description of any wetland and woodland areas or unqiue ecosystems that would be affected.

The major plant communities were discussed in Section 2.2.1 of the DES, wetlands were discussed on page 2-65 of the DES, and woodlands were discussed on page 2-67. Since most of the vegetation disturbed would be weedy ROW, maps showing major plant communities would be of only minor value.

Page 2-67--There is a discrepancy between Section 2.2.2.4 which states that the proposed pipeline route would traverse 8 miles of woodland and Page 3-39, Table 3-15, which indicates that the pipeline would traverse 31.8 miles of woodland. In addition, both figures appear to conflict with Table 3-16 on Page 3-41 which gives no definite indication that woodlands would be affected by the proposed pipeline. The number of acres of woodland to be cleared, both on and off the railroad right-of-way, should be clearly indicated on Table 3-16.

The values in Section 2.2.2.4 and Table 3-15 have been corrected. Table 3-16 is correct as the railroad ROW through the woodlands is generally already cleared and the amount of additional clearing necessary for the pipeline would be small, but is not exactly known.

Page 2-79--Endangered species of plants and animals and their respective habitats known to occur along the pipeline route should be tabulated.

Except for migrant birds, no endangered plants or animals would be found along the route.

Page 3-7--Section 3.1.1.2 does not discuss the air quality impact that could result from operation of the two proposed compressor stations. This impact, as well as the compressor noise impact, should be evaluated.

A paragraph on the air quality impacts of the two compressor stations has been added to Section 3.1.1.2. We do not believe the noise of the compressors would be audible more than a few feet away from the buildings in which they would be enclosed.

J-58

Page 3-25--Section 3.1.2.2 should discuss whether the proposed SNG pipeline construction would affect the near-surface groundwater flow conditions in the Red River Valley, mentioned on Page 2-39.

As mentioned on page 2-39 of the DES, the closest point of the aquifer to the surface is 10 feet. Since the bottom of the pipeline trench would be 6½ feet deep, there would be no impact.

Page 3-31--The soil types listed for the proposed SNG pipeline route in Table 3-12 are inconsistent with those listed in Table 2-12. For both tables the criteria used in determining erosion potential and/or revegetation difficulty should be explained and the data sources identified. Would it be possible to mitigate or avoid the "large" potential erosion impact identified for soils near the proposed plant site in Table 3-12?

Table 12 refers to soil associations which are broad categories including two or more soil series. The basis for determining erosion and/or revegetation problems was standard Soil Conservation Service definitions for these soils. Special precautions will be taken to avoid or correct the problem areas shown in Table 3-12, as any disruptions of the pipeline would be very costly to ANGCGC.

Page 3-32--The impact of constructing the pipeline within areas of potential subsidence and sand blowouts, noted on Page 2-56, should be evaluated.

The second paragraph under Section 3.1.3(d) has been rewritten to include sand blowouts.

Page 3-38--In Section 3.2.1.5(a), it is stated that 79 acres of cropland would be permanently lost to agricultural production because of right-of-way maintenance. This statement should be further researched to assure its accuracy inasmuch as the

The 79 acres would only be lost for one season (during construction) and the section has been revised accordingly.

maintenance of pipeline rights-of-way does not normally preclude using the land for cropland or pasture.

Page 3-48--Section 3.2.3(c) incorrectly refers to aquatic ecosystems defined in Table 2-14. The reference should be to Tables 2-6 and 2-7, not Table 2-14.

The reference has been corrected to Table 2-6.

Page 3-49--The 600 feet of spawning grounds mentioned in Table 3-17 should be fully discussed in the FEIS, including the name of water bodies involved and the species using the spawning grounds.

The fact that the 600 feet of potential spawning grounds is along the shoreline of Lake Sakakawea has been added to the EIS; species sampled along the shoreline were shown in Appendix G.

Page 4-4--Mitigating measures to reduce the adverse impact of constructing and operating the proposed SNG pipeline, compressor stations, communication towers, and district headquarters building, should be discussed in detail in Section 4 under a separate heading.

Mitigating measures for these facilities are discussed in Chapter 4 in relation to the resource impacted, rather than by project feature.

J-59

Plant and Product Pipeline Alternatives

Page 8-2--The DEIS states, "Because of the geographical location of the American Natural Resources System away from coastal areas, they do not consider LNG imports an economically attractive alternative." It should be noted that the Michigan-Wisconsin Pipeline Company pipeline system, which comprises a major portion of the American Natural Resources System, presently extends to natural gas production areas in the Gulf of Mexico. An LNG terminal proposed by Trunkline LNG Company for the same general gulf coast area has recently been approved by the Federal Power Commission and will provide service to the upper Midwest.

The paragraph has been rewritten in light of a reevaluation of LNG imports by American Natural Resources Company.

Page 8-11--It is impossible to derive a satisfactory understanding of the site selection process from the material presently given in Section 8.2 of the DEIS. No explanation is given of the siting criteria or site selection methodology used. No maps are provided to indicate the location of the alternative sites relative to their surroundings. At least two sites, designated as 3A and 5C, appear to merit more detailed discussion than is presently given through the numerical rating format used in the DEIS.

Inclusion of a detailed explanation of all siting criteria, many of which have no environmental bearing, would not add to this Chapter which is intended to portray the environmental aspects of different alternatives. Since the alternative sites are potential sites for future development, their locations are not revealed except to Government agencies upon special request and under strict confidentiality.

Page 8-14--The prospect of various new coal-related energy developments in the general project area suggests the need for coordinated regional planning of utility transmission corridors. The FEIS should discuss what authority or ongoing programs the states of North Dakota and Minnesota have to implement a planned utility corridor concept. The FEIS should give recognition to the potential savings such a planned utility corridor might provide for the proposed project by allowing a more direct pipeline route configuration. The FEIS should provide a map illustrating regional coal resources and the location of any presently proposed electric power transmission lines or coal slurry pipelines associated with proposed electric generating facilities under consideration for the general project area.

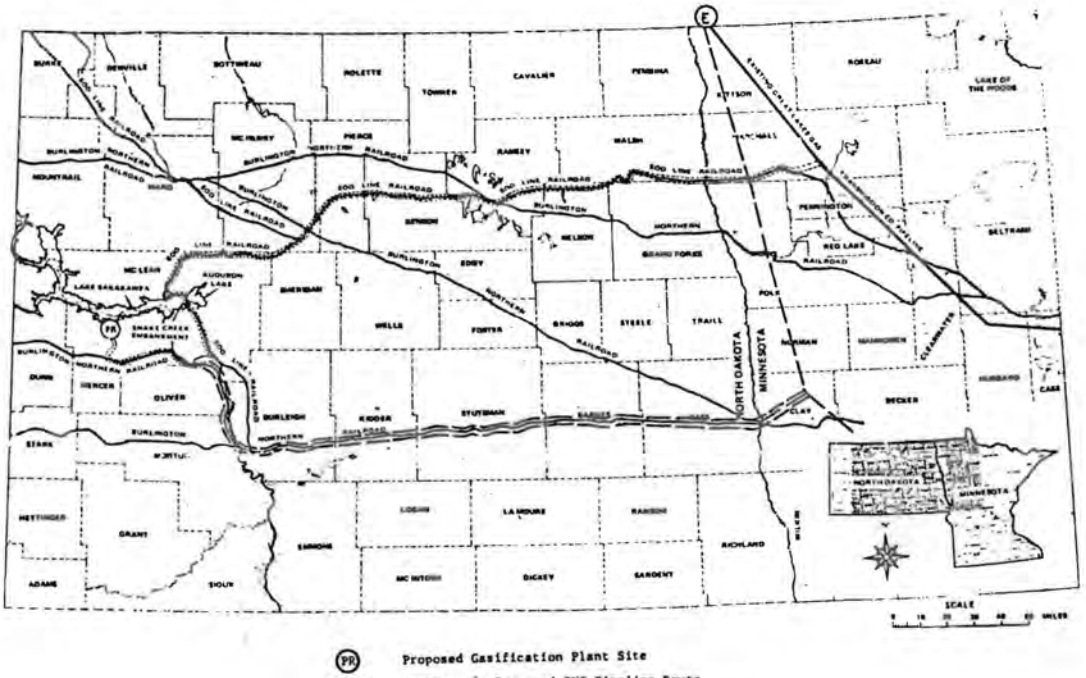
As mentioned on page 1-13 of the DES, the BLM-North Dakota Regional EIS is designed for regional planning and these matters should be discussed in their document.

Page 8-16--The alternative of connecting the proposed SNG pipeline with the proposed Northern Border Pipeline Company project (Northern Border) merits more attention than it is presently given in the DEIS. In its recommendation to the President of the United States, the FPC has endorsed an overland Alaska gas pipeline route, which would include some version of the Northern Border pipeline. While the Northern Border pipeline could require changes in capacity to accommodate the proposed volumes of SNG, the associated economic and environmental costs associated with these changes would in all likelihood be far less than those associated with development of the applicant's proposed SNG pipeline route. Differences in BTU-rating between the SNG and Alaskan natural gas is not a significant problem and should not exclude more detailed consideration of the Northern Border alternative.

We agree that the Northern Border Pipeline would be an excellent alternative to the proposed pipeline if it is actually built. However, a large degree of uncertainty exists as to if the pipeline will be built, where it would be routed, and if it would be built soon enough to provide a connection to the proposed plant.

Page 8-16--The FEIS should consider an alternative SNG pipeline route designed to interconnect with the 24-inch Midwestern Gas Transmission Company (Midwestern) pipeline at a point in Clay County, Minnesota. (See attached diagram.) This route would follow an existing Burlington Northern Railroad right-of-way for most of its distance and would be approximately 60 miles shorter than the presently proposed SNG pipeline configuration. Natural gas which is presently transported by the Midwestern 24-inch pipeline would be diverted to the existing Great Lakes pipeline at an exchange point near the Canadian border. This exchange of gas would allow the Midwestern 24-inch pipeline to accommodate the proposed volumes of SNG. It is expected that the pipeline looping requirements on the Great Lakes and Michigan-Wisconsin pipeline systems would remain essentially the same as currently proposed.

About 25 miles of additional pipeline looping would be required, thus the actual distance savings would only be 35 miles. About 30 miles of Missouri River bottom would be traversed between Washburn and Bismarck; this area has an abundance of bottomland hardwoods which is extremely valuable wildlife habitat. The FPC route would go through the major cities of Mandan, Bismarck, Jamestown, Fargo, and Moorehead with attendant adverse environmental and social impacts not present with the proposed route. Also, the FPC route would parallel Interstate 94 between Bismarck and Fargo (193 miles) and may result in traffic interference and public safety hazards during construction. For the above reasons, the proposed route is considered more suitable.



(PR) Proposed Gasification Plant Site

Applicant's Proposed SNG Pipeline Route

FPC Environmental Staff's Proposed Alternative SNG Pipeline Route

(E) FPC Environmental Staff's Proposed Gas Exchange Point

Existing Midwestern Gas Transmission Co. Pipeline

DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE
OFFICE OF THE SECRETARY
WASHINGTON, D.C. 20201

MAY 13 1977

Mr. D.D. Anderson
Acting Commissioner
United States Department of the Interior
Bureau of Reclamation
Washington, D.C. 20240

Dear Mr. Anderson:

We have reviewed the draft Environmental Impact Statement for the DoI/BR ANG Coal Gasification Company, N. Dakota Project and we feel that with the following exception the expected environmental impacts of the proposed project have been adequately addressed.

A rather serious printing and collating error occurred in Section 2 which made it difficult to have an appreciation of the existing environment in the section of North Dakota planned for this project.

In Section 3, it would be appropriate to include an impact analysis on occupational health. For this purpose, the impact statement writers could take advantage of a recent draft document from NIOSH on recommended guidelines for occupational exposures in coal gasification pilot plants. Certain pilot plant operations differ considerably from full scale plant operations. The NIOSH document, however, describes each unit operation and problem areas encountered during normal operation, maintenance, and emergency situations that could produce significant employee exposure to hazardous materials.

We appreciate the opportunity to review this document.

Sincerely,

Charles Custard

Charles Custard
Director
Office of Environmental Affairs

J-62

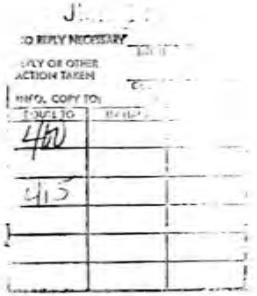
No response necessary.

Apparently this error was only in the one copy of the statement, not the entire printing.

ANGCGC has obtained and reviewed the draft document from NIOSH on recommended guidelines for occupational exposures in coal gasification pilot plants. ANGCGC agrees that measures can and would be taken to restrict personnel exposure to harmful substances. ANGCGC's chief physician is experienced in occupational health applications and will develop final specifications governing health and safety measures to be employed at the new facility. The NIOSH report has been made available to him for use in developing the criteria. We believe there would be no unusual impacts to occupational health if proper measures are taken.

UNITED STATES
ENERGY RESEARCH AND DEVELOPMENT ADMINISTRATION
WASHINGTON, D.C. 20545

MAY 3 1 1977



Office of the Regional Director
ATTN: 415
Bureau of Reclamation
P. O. Box 2553, Federal Building
Billings, Montana 59103

Dear Sir:

This is in response to your transmittal dated March 22, 1977 in which you invited the Energy Research and Development Administration (ERDA) to review and comment on the U. S. Department of the Interior, Bureau of Reclamation's draft environmental impact statement on the ANG Coal Gasification Company, North Dakota Project.

We have reviewed the draft statement and have determined that the proposed action will not conflict with current or known future ERDA programs. However, we are enclosing staff comments which relate basically to socioeconomic effects. You may wish to consider these comments in the preparation of the final statement.

Thank you for the opportunity to review and comment on this draft statement.

Sincerely,

W. H. Pennington, Director
Office of NEPA Coordination

Enclosure:
ERDA Staff Comments

cc w/enclosure:
Council on Environmental
Quality (5)

No response necessary.

ERDA STAFF COMMENTS

DOI/BOR DRAFT ENVIRONMENTAL STATEMENT

RELATED TO THE ANG COAL GASIFICATION COMPANY

NORTH DAKOTA PROJECT

In general, this appears to be a good document in describing the physical impacts and associated mitigating measures of the project. Physical disturbances such as emissions, ground aquifer and surface water disturbances were determined to be significant as were the socioeconomic impacts created by a large population of new workers. Cumulative impacts of the ANG project and six other similar projects in Mercer County, appear to be of greater significance than those from only the ANG facilities. These cumulative impacts, as noted in the document will be evaluated in a follow-on EIS. Our specific comments to the ANG EIS are as follows:

J-64

Section 1

The "Description of the Project" does not take into account the socioeconomic impacts of the electric powerplant. Labor force data do not appear to reflect the associated powerplant facility.

No response necessary.

- Socio-demographic characteristics of the existing population and government structures are missing. This is an impediment to a comprehensive assessment of the impacts of the project and a more meaningful discussion of "Mitigating Measures."

Labor force data for the powerplant were shown in Table 3-18 of the DES. They were not included in Chapter 1 because the Basin Electric powerplant is not the subject of this EIS.

Socio-demographic characteristics of the existing population were discussed in Sections 2.3 and 2.4 of the DES.

Section 3

In general the coverage is adequate and the emphasis is well directed. All tables should be referenced, however, and methodology clearly stated.

Except for those specifically referenced, the Tables in Chapter 3 were produced by Bureau of Reclamation personnel based on information provided by ANGCGC, Woodward-Clyde Inc., and Ecology and Environment Inc., and other State and Federal agencies. Methodology where appropriate is footnoted.

- Basis for estimating the immigrant worker population is not given.

The basis for immigrant worker projections were footnoted in Table 3-21 of the DES.

- The method for estimating population should take into account family size by age, for construction and separately for operating and secondary work force.

These factors were taken into account in the multipliers used to estimate the immigrant population.

- Since population estimates are a key issue, and the findings are not consistent with such sources such as the Construction Worker Profile, it is difficult to evaluate the estimate.

Several sources were used in making population estimates and these were cited in the DES; the Construction Worker Profile was one, but not the only one, of the sources used.

- In-migrant workers data in table 3-21, appear to be inconsistent with the scenario described on the preceding page.

- If earnings include secondary workers, the estimate appears to be high.

- The basis for estimating school age population is not given. Without estimates of population by age it is difficult to evaluate the percentages.

- Recreation needs are very well analyzed.

Section 4

- Section 4.3 describes plans for monitoring of air, water and biological (wildlife) environments. It was noted in Section 3.1.13(c) that there may be potential adverse impacts on human health due to particulates and trace pollutants from strip mining and coal gasification operations. Since the degree of impact is uncertain, we would recommend the addition of health effects monitoring in Section 4.3.

Section 8

The mitigating measures for socioeconomic emphasis are inadequate. This is an important part of the EIS since it can provide guidelines to state and local decisionmakers. North Dakota is one state that does have substantial existing and potential mechanisms for alleviating adverse impacts, yet none are mentioned.

We can find no inconsistencies in the scenario or table.

The earnings include secondary workers, and we believe the estimate is accurate.

The source for the school age population estimate was referenced on page 3-65 of the DES.

No response is necessary.

We acknowledge and agree with this comment; the suggestion has been transmitted to ANGCGC.

State measures available to lessen socioeconomic impacts were discussed in Sections 2.3.2. and 3.3.2.8. of the DES. These measures were not included in Chapter 4 because they were considered to be general mechanisms, not mitigating measures that can be imposed upon the applicant by the Federal Government.

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY

REGION VIII
1860 LINCOLN STREET
DENVER COLORADO 80203

JUN 13 1977

Ref: 8W-EE
D-IBR-J09001-ND

Mr. D. D. Anderson
Acting Commissioner
Bureau of Reclamation
U.S. Department of the Interior
Washington, D.C. 20240

Dear Mr. Anderson:

J-99

We have reviewed the draft EIS for ANG Coal Gasification Company's North Dakota Project. Our concerns about the project cover a broad range of environmental issues. These issues are summarized below and outlined in more detail in the attached comments.

1. The EIS does not adequately discuss the emissions of air pollutants from the plant and the incremental effects of these emissions on the region's overall air quality.

   See response under comments section of letter.

2. The increased noise levels caused by the project appear to have been underestimated.

   See response under comments section of letter.

3. Solid waste disposal in the mined out areas may contaminate near-surface aquifers and adversely impact wells and springs in the project area.

   See response under comments section of letter.

4. Impacts on water quality are not adequately addressed, especially as these impacts may affect the ability of streams to meet State water quality standards.

   See response under comments section of letter.

5. Post mining land use and reclamation efforts are addressed only vaguely.

   See response under comments section of letter.

6. The project will destroy nearly 100 acres of prime wetlands and disturb an unknown acreage of additional wetlands.

   See response under comments section of letter.

7. The socioeconomic environment is not adequately described, impacts on the socioeconomic environment are discussed in vague terms, and few specific measures to mitigate these impacts are provided in the EIS.

See response under comments section of letter.

8. Adverse secondary impacts on significant historical and archaeological resources may occur unless mitigating measures to protect these values are implemented.

See response under comments section of letter.

9. The discussion of alternative sites is inadequate, and only a narrow range of possible alternatives to the proposed project was considered.

See response under comments section of letter.

In view of these concerns we have rated the EIS ER-2, which means that EPA has serious reservations about the environmental impacts of the project, and that the EIS is deficient in some major areas of information. Please do not hesitate to contact this office if you have any questions about our review.

J-67

Sincerely yours,

John A. Green
Regional Administrator

Enclosure

Detailed Comments: ANG Coal Gasification Company EIS

Description of Proposed Project

Section 1.2.2. The synthetic natural gas (SNG) supplies shown in Table 1-1 for 1982-1984 are incorrect in that the second 125 MM cf (Phase II) is not scheduled to be operational until 1987. In addition, the value for SNG supplies for 1981 should be 45,625 MM cf (instead of 48,500 MM cf) unless ANG is including additional SNG to be produced by development that is not addressed in the EIS.

The table has been revised in line with this comment.

This section also discussed the need for the project and displays the priority categories of customers. To what degree is the project needed in order to provice service to new customers? Insofar as the costs of the project will be borne by all of ANG's customers, to what extent are they subsidizing expansion of the company and its markets?

As shown on Table 1-6, the SNG would be used to maintain existing supply, not to develop new markets. In as much as no new markets would be created, the company is not expanding.

Section 1.5.4.6 According to the latest information available to EPA the final decision as to what will be done with the gas escaping during the operation of the coal lock has not yet been made. The first paragraph in 1.5.4.6.a should be revised to reflect the uncertainty of the situation, rather than stating that the gas will be ejected from the lock and incinerated.

The paragraph has been revised to say that 98 percent of the gas would be returned to process, and 2 percent exhausted into the atmosphere.

Section 1.5.4.7 The emergency steam supply that is to be purchased from Basin Electric should be addressed in more detail. First, if Basin Electric is to provide this emergency steam, will additional capacity have to be built into the powerplant, and, if so, at whose expense (Basin Electric's customers or ANG) will the additional capacity be provided? Will Basin Electric experience a reduction in generating capacity when emergency steam is being supplied to ANG? Will emergency steam be provided only until the gasification plant can be shut down, or is longer term use of steam from Basin Electric contemplated? What will be the fate of the ANG project if the Basin Electric facility is not built, or is delayed?

No additional capacity is planned for the powerplant. The powerplant would probably experience a short-term loss of production while providing steam to ANGCGC. Steam would be provided only for short periods of time. The ANGCGC facility would be built even if the Basin Electric plant is not (See discussion of alternative sources of power in Section 8.1.3.3).

Section 1.5.5.3 We have the following questions and comments regarding the gaseous effluent system discussed in this section.

1.) For H_2S removal:

a. What is the CO_2 concentration of the gas stream entering the Stretford Unit?

Approximately 95.5 percent.

b. What is the H_2S concentration of the gas stream entering the Stretford Unit?

Approximately 1.0 percent.

c. What is the SO_2 and sulfur compound concentration of the gas stream entering the Stretford Unit?

There is no SO_2 in this stream. The total COS and organic sulfur content would be about 240 ppm.

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2. For NO_x:

a. Are any procedures to minimize NO_x formation contemplated? (e.g. overfire air, steam injection, etc.)

Yes; tangential firing, overfire air, and low excess air firing.

b. What is the nitrogen content of the tar and tar oil? What are the feed rates of tar and tar oil to the boiler and superheater?

Approximately 1.0 wt percent and 0.6 wt percent, respectively. Feed rates to the boilers are: Tar 70, 120 lbs./hr., Tar Oil 9,390 lbs./hr.; for the superheater: Tar Oil 14,000 lbs./hr.

Finally, coal lock ejector gas is no longer being considered for use in the superheaters because of technical difficulties (See comments on Sec. 1.5.4.6).

Section 1.5.4.6 has been revised.

Section 1.5.5.6. In addition to complying with State and Federal regulations concerning emissions of hydrocarbons from the storage facilities discussed in Section 1.5.5.6 and Table 1-9, ANG may be required to develop a Spill Prevention Control and Counter Measure Plan (SPCC) for the facility. We also recommend monitoring groundwater in the vicinity of the underground storage tanks for anhydrous ammonia, so that leaks can be detected and repaired promptly.

We acknowledge this comment and have sent the recommendations to ANGCGC.

Section 1.5.6.1 The last paragraph of this section mentions that two compression stations encompassing 10 acres each will be built at some time in the future, however, the impacts of these activities are not specifically addressed in the EIS. Will an addendum document be prepared to discuss the impacts from construction of these facilities?

Air Quality Impacts

Air quality impacts of the compressor stations have been added to Section 3.1.1.2.(4). See also response #4 on page J-19.

According to Figure 2-2, the winds in the study area do not prevail from the east on an annual basis, suggesting a need for a more detailed study of the meteorological conditions during the fire at the coal mine east of the meteorological test site so that the extent of the fire's contribution to the SO_2 values measured at the site can be determined. The concentrations of total suspended particulate matter (TSP) at the same site were high; what is the explanation for these values? Why were repeat samples not conducted for TSP as they were for SO_2? These observations, since they consist of measurements of air quality under "real life" meteorologic and atmospheric conditons, may provide valuable insight into the behavior of pollutants under the climatic regimes of the study area and thus supplement the postulations of the air quality model.

Meteorological data for the summer months in question show that winds from the east and southeast are quite prevalent. Examination of hourly data collected during the monitoring period indicated that there was a correlation between periods of easterly and south-easterly winds and high SO_2 levels. The TSP levels were not high considering the active farming in adjacent areas. Extension of TSP monitoring was not necessary because the State Health Department maintains an air monitoring site at the same location.

Although fugitive dust control is discussed in regard to pipeline construction, it is not addressed in relation to the construction phase of the plant, nor are fugitive dust emissions from operation of the mine included in the air quality model. Since preliminary emission factors for strip mining operations are now becoming available, the fugitive dust emissions from the ANG/Basin Electric project's mine should be estimated and included in the air quality model. What, if any, fugitive dust controls will be implemented during construction of the plant and mine?

Fugitive dust emissions related to plant construction were discussed on pages 3-1 and 3-2 of the DES and the method used to estimate these emissions was discussed on page I-3. Modeling procedures for these emissions were given on pages I-10 and I-11 of the DES. On page I-29, fugitive dust emissions related to mining were discussed. Dust abatement practices were discussed in Section 4.2.1.2.

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Tables 3-1 and 3-4 display expected emissions from vehicles used at the plant and the mine sites respectively, however, it is unclear if the emissions listed are for all of the engines or just one. Does table 3-4 include emissions from generating the electricity needed to power the draglines and electric loading shovel (cf. Sec. 1.5.3.1.d)? What emission factors were used to calculate these emissions and why were hours of operation chosen over vehicle miles traveled (VMT)?

As stated on page 3-2 of the DES, the emissions are based on 20 engines of each type. The emissions for generating power to operate the dragline and shovel are included in Basin Electric's emissions on page 3-7 of the DES. For heavy equipment, hours of operation are more appropriate than VMT.

The discussion of odors in Section 3.1.14 overlooks the possibility that if leaks do occur in the piping system at the plant H_2S emissions could become a significant odor problem. EPA believes that the whole subject of non-criteria pollutants that may be emitted from the project requires more attention, both in assessing and in mitigating their possible impacts on air quality. Although these emissions are discussed in vague terms where blowdown from the plant is discussed, we feel that the toxicity of some of these pollutants merits more serious and detailed discussion. Section 4.1.2.1 correctly states that the plant would have to meet EPA's forthcoming New Source Performance Standards for coal gasification operations. There is, however, a minor error in the NSPS figures tabulated at the bottom of page 4-1; at the present time, there is no SO_2 standard for steam boilers burning gaseous fuels.

Any leaks in the piping system which emit H_2S would be quickly recognized and corrected by plant personnel. Any emissions of noncriteria pollutants would be of short duration. Safety equipment would be available to plant personnel and detectors with alarms will be installed in enclosed buildings where any build up of these gases could occur.

The discussion of Prevention of Significant Deterioration (PSD) requirements in the EIS needs improvement. First, tables 3-5 and 3-7 incorrectly note that the Class II PSD requirements for 3-hour and 24-hour SO_2 levels may not be exceeded more than once per year. Actually, under Class II these levels of pollution are never to be exceeded. What is the basis for the allowable Class II PSD increment that is shown for the project in Section 4.1.2.1, and what percentage of the allowable increment will be used by the Coyote plant? The possibility that Dunn County will be designated a Class I area should also be taken into consideration since the proposed project could impact air quality there during periods when the air is stagnant or moving from east to west.

The tables have been corrected. As stated on page 4-2 of the DES, the bases for the increments were the calculated ground-level concentrations in Table 3-7. Incremental use by the Coyote plant will be discussed in the REA site-specific EIS. Preliminary evaluations indicate that only the ANGCGC plant could meet a Class I designation in Dunn County.

The section on cumulative impacts on air quality (3.1.1.3) should be expanded to include more scenarios, including (a) ANG without Basin Electric using an outside source of power, (b) ANG without Basin Electric, with power being generated by ANG, and (c) ANG, Basin Electric, and the Coyote plants together. Although the impacts of ANG and Basin Electric are tabulated together in table 3-6, the cumulative effects of both facilities on the total pollutant concentrations in the region is not addressed.

The proposed action is ANG with Basin Electric and the impacts of the proposed action are discussed. As mentioned on page 1-13 of DES, the BLM-North Dakota Regional EIS is designed to study cumulative regional impacts; therefore, such impacts are not covered in great detail in our site-specific EIS.

Insofar as the Dispersion Analysis (Appendix I) is an important element of the overall air quality analysis, the following comments are specifically addressed at the modeling effort for the project. EPA will provide an independent air quality modeling effort during its PSD new source review. The preliminary review and proposed decision to approve

No response necessary.

or disapprove the permit to construct the ANG plant will be made available for public inspection and comment during July.

1. A sub-routine was added to the Unamap models to allow for jet (non-bouyant) plumes. Why were not sub-routines added to account for low temperature plumes? (e.g., coal handling equipment, etc.)

Low temperature plumes have little bouyancy and were considered jet plumes in the modeling.

2. Are the fugitive emissions from the mining operations included in the fugitive dust emissions from the total construction site (see Table I)?

No, they were shown in Table XV, page I-29.

3. The emission rates and stack parameters listed in Table II are not identified as average or maximum values.

The table has been changed to indicate that they are maximum rates.

4. Table II does not include emissions from the Coyote power plant. Why is this facility not included in the analysis?

Emission and stack data for this facility were not available when the table was prepared but should be included in the BLM-North Dakota Regional EIS.

5. In Table IV, the second maximum pollutant concentrations for short-term values and the location of the receptor where the value is predicted should be listed.

The pollutant concentrations in Table IV are maximum concentrations outside the plant boundary.

6. When the CDM was run for ANG, was it calibrated with known air quality data? If so, where is the calibration curve?

No., existing and proposed plants were included in the CDM; the following values were used as background: NO_2-5μg/m^3, SO_2-5μg/m^3, TSP-25μg/m^3.

7. Can the estimated pollutant concentrations due to community growth be added to the industrial values at the same receptor locations? Furthermore, what are the estimated vehicle miles traveled (VMT) as a result of the project, and does this figure support the assumptions about the impacts of automobile traffic shown on Page I-35 of the document?

The estimated pollutant concentrations due to community growth were given in Table XVI, Appendix I. Estimates of VMT are 15,000 miles/day; however, since 25 percent of the workers would commute over 50 miles/day, effect on air quality cannot be related to any specific receptor point.

8. Basin is to meet the NSPS 1.2 lb $SO_2/10^6$ BTU and a scrubber for SO_2 is to be installed. Uncontrolled emissions from Basin burning .7% S lignite yields 1.45 lb $SO_2/10^6$ BTU and maximum emissions from 1.7% S lignite yield 3.5 lb $SO_2/10^6$ BTU. What is the control efficiency of the SO_2 scrubber and what percentage sulphur content in lignite is the efficiency based on?

The control efficiency of Basin's SO_2 scrubber would be 42 percent for lignite with 0.68 percent sulfur and 70 percent for 1.22 percent sulfur.

Noise Impacts

We are concerned about the possible impacts of noise on rural inhabitants of the study area, some of whom may have chosen to live in the area expressly for the purpose of escaping from the noise of more developed areas. Although only a few people may be impacted by the increased noise that is anticipated as a result of the project, its impacts on these individuals may be significant because of high expectations and desires for an environment that is free from the intrusions of industrial noise.

Most of the inhabitants are decendants of persons who settled the area in the late 1800's. Noise impacts are unpleasant and these impacts have been discussed in Section 3.1.1.5. of the EIS.

Noise levels measured by EPA 100 feet from railroad rights-of-way showed the following:

1) L_{eq} (24) at 8 sites ranged between about 65 and 70 dB(A) and L_{dn} ranged between about 69 and 73 dB(A).

2) Hourly L_0 (or maximum sound level) at three sites ranged from 50 to 114, 53 to 110, and 58 to 105 dB(A) respectively.

Although these data do not specifically single out the effects of the typical freight train servicing the project, they do suggest that 75 dB(A) at only 50 feet distance is a low estimate of the noise levels caused by rail traffic. Furthermore, we recommend the practice of reducing train speeds through populated areas as this decreases noise levels and provides some additional safety benefits as well.

The reference to 75 dBA at 50 feet from the railroad was taken from a pamphlet entitled "Noise Pollution" which was published by EPA, 1972. The trains would operate at low speeds on the spur line thus minimizing noise.

The 40 dB wind induced average ambient sound level used on page 3-20 in analyzing the construc ton noise impact may not be a true representation of the audible ambient noise levels in the area. While noise monitoring microphones are estremely sensitive to pressure fluctuations caused by wind, the human ear is not, and the actual audible ambient level would be less than 40 dB. In fact, as figure 2-11 indicates, at wind speeds of less than 10 mph the actual ambient, without wind error, would be 30 dB or less. Hence, using a 30 dB ambient in the analysis of construction noise would suggest that noise associated with this activity could be audible at 5 miles (as is displayed on page 3-20) as opposed to 1-1/2 miles using the 40 dB ambient (as indicated in the text of the first paragraph of page 3-20).

A wind screen was used on the microphone to reduce sensitivity to the wind. The noise levels presented reflect this reduction. The average wind speed at the plantsite was 11.6 mph (page 2-3) and the L_{50} noise level associated with this wind speed is about 40dBA (Figure 2-11). We acknowledge that during calm conditions noise would travel further.

We recommend that noise abatement and control be designed into the building design and purchase specificaitons for the project, as the most effective and economical solutions to interior noise attenuation problems can be implemented through good design practices. For example, depending on the design and materials selected, transmission loss in walls may range from less than 20 dB to as much as 50 dB.

ANGCGC has indicated that noise abatement and control measures would be designed into the plant buildings and specified on equipment orders.

Finally, we believe that efforts should be made at the county planning level to assure that development plans for the area in the vicinity of the project are compatible with the operation of the plant and the mine. We believe that such measures are less costly and far more efficient if they are implemented before conflicting uses occur.

We agree with this comment. County planning efforts are discussed in Section 3.3.2.8 of the EIS.

Solid Waste Impacts

We are concerned that the draft EIS is vague in its discussion of solid waste disposal, especially in regard to potential contamination of groundwaters. In planning for a project of this type and magnitude all solid

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wastes from the plant should be analyzed to determine their chemical constituents, toxicity and solubility. These data, coupled with the moisture content of the wastes and the geohydrologic conditions of the site will determine whether wastes can be deposited in the mine without contaminating groundwaters. The draft EIS alludes to the possibility that groundwaters could be impacted by "infiltration of mine pit effluent (page 3-26)," but it addresses neither the possible impacts of the solid waste disposal practices contemplated by the company nor studies of the type outlined above. We believe that, as a minimum, the final EIS should display the results of this kind of an investigation, including a determination of what measures (e.g. chemical fixation, sealing the solid waste disposal areas, dewatering of wastes, reprocessing catalysts, etc.) might be needed in order to assure that the wastes deposited in the mine do not eventually contaminate near-surface aquifers and wells.

As mentioned on page 3-28, a 2 year geohydrologic study of the mine area is being undertaken and determinations as to the necessity of mine pit sealing will be made after the study is completed. We do not believe the final statement should be held up 2 years to await final solution of this problem as the State Health Department and Public Service Commission will review this problem before any permits are issued to allow the disposal of wastes in the mine pit.

Finally, the Division of Solid Waste Management in the State Health Department should be consulted regarding the permits required in order to dispose of wastes in the mine pit, as well as any special requirements for the disposal of hazardous waste materials. Permits may also be required for evaporation ponds and storage tanks if the possibility of leakage or uncontained spills exists.

The State Health Department will require a permit for solid waste disposal and the North Dakota State Water Commission will require permits for any ponds having a potential discharge.

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Water Quality Impacts

Despite the fact that the major Federal Action being addressed in the EIS is ANG's application for Missouri River water, the document contains little discussion of either the impact of the proposed use of the water (17,000 afy for ANG and 19,000 afy for Basin Electric) on programs like the Bureau of Reclamation's Water for Energy Program or the impacts of construction and operation of the intake structure. In regard to the former, does the proposed withdrawal of 36,000 afy impact the "Water for Energy-Missouri River Reservoirs" program? What is the status of the agreement between the Bureau and the State of North Dakota on marketing Missouri River water? Regarding the intake structure, how is it designed, how will it be constructed so as to minimize damage to aquatic ecosystems and water quality, and what kinds of maintenance or repair operations are envisioned in the last paragraph of section 3.2.1.3?

The water to be sold to ANGCGC and Basin Electric is part of the industrial water marketing program and was included in the Water for Energy EIS. North Dakota has declined the USBR's offer of joint contracting of industrial water. Design and construction features of the intake were discussed in Section 1.5.6.2 of the DES; impacts were discussed in Sections 3.1.2.1, 3.2.1.3, 3.2.1.6, 3.2.2.3, and 3.2.3. Maintenance and repair operations would entail oiling and inspecting the pumps, replacing inoperative parts, etc.

Another area of impact that should be clarified in the final EIS is the approximate amount of water that will be released into the atmosphere of the study area and the probable impacts of water releases on local climatic conditions. The total amount of water to be discharged into the atmosphere by ANG as indicated in section 1.5.5.4(c) appears to be incorrect; if blowdown shown in table 1-8 is excluded, the total discharge of water into the atmosphere amounts of 5094 gallons per minute rather than 4700 gpm.

The amount of water released into the atmosphere has been reevaluated and is now estimated to be 7,720 gpm. Section 1.5.5.4 has been revised accordingly. Section 3.1.1.1 discusses the impacts of water releases on local climatic conditions.

Furthermore, the discussion of the impacts of these discharges on the climatic conditions of the study area should be expanded to include the cumulative impacts of ANG and Basin Electric's evaporation and drift. Finally, are these evaporative losses of water consistent with the first condition attached to North Dakota's water permit (Sec. 4.5.1)?

The entire discussion on air quality includes impacts of the Basin Electric powerplant, thus the cumulative impacts of evaporative drift are discussed. The BLM-North Dakota Regional EIS will include the impacts of all five projects proposed for the region.

EPA supports the strategy of diverting stormwater runoff from clean areas on the plant site and natural drainage from surrounding areas into open ditches and ultimately into the natural drainage system (Sec. 1.5.5.2). These onsite drainage ditches should, however, be designed to minimize the erosive force of the runoff, using adequate drop structures and other energy dissipators as needed. The stormwater runoff collection and retention systems for paved areas, materials storage areas, and other on-site sources of potential contamination should also be adequately sized to handle the runoff from the 24-hour once in ten years precipitation event. Another problem that should be given consideration in this regard is the method of handling accumulations of contaminated snow. Snow that is removed from contaminated areas should not be left in natural drainages to melt and release pollutants into surface waters.

The storm water structures would be designed to minimize erosion as suggested. Drop structures and energy dissipators are not needed due to the relatively level topography and the absence of steep gradients. Runoff collection and retention systems are designed to handle a 25-year precipitation event and snow from contaminated areas would be placed so that the runoff enters the treatment systems.

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In view of the wide variety of soils that will be encountered during pipeline construction (See table 2-12) and the sensitivity of some of these soils to wind and water erosion, extra care should be taken to assure that construction practices do not result in erosion problems. Field construction crews should include someone who is knowledgeable in conservation practices suited to the locality and has the authority to require that conservation practices are implemented during construction.

We agree with this comment. It is also in the best interest of the pipeline company to insure that erosion does not occur so as to minimize maintenance costs.

The discussion of water quality monitoring programs (Sec. 4.3.2.1) does not include any indication of the frequency of monitoring in the subbasins prior to mining. Will samples be collected only once, at the beginning of snowmelt, or will a sampling program begin at that time and continue at intervals through the year? Regarding discontinuation of monitoring stations after completion of the reclamation program within the subbasins we have two questions. First, does completion of reclamation mean successful revegetation and establishment of the post-mining land use (e.g. cropland), or does it mean simply that the land will have been shaped to its ultimate topography and topsoiled? Secondly, what does ANG regard to be unacceptable in the criteria for continued water quality monitoring in these subbasins, and what kinds of corrective measures are they committed to taking? Finally, in regard to the baseline data presented in the EIS we noted an inconsistency between Figure 2-32, which shows the dissolved oxygen change in June is from approximately 10 mg/l to 8 mg/l and the text (Sec. 2.1.3.2.a), which states that the change is from 10 mg/l to 6 mg/l.

Details of the water quality monitoring program will be specified by the State Health Department and the Reclamation Division of the Public Service Commission. Mined areas would be monitored until the reclaimed land is released from bond by the PSC. Since mining in a subbasin would continue for many years, water quality monitoring would continue long after release of certain areas. The State Health Department would determine what criteria are unacceptable and the corrective measures needed would depend on the nature of the problem. The reference on page 2-41 has been corrected.

Contrary to the last paragraph in Sec. 2.1.3.1, the "best use" classifications shown in table 2-7 are not discussed in the section on water quality or elsewhere in the EIS. The whole issue of whether or not North Dakota and Minnesota water quality standards will be violated as a result

As mentioned on page 4-2 of the DES, the project would not violate any water quality standards. We have no reason to believe that Minnesota waters would be measureably affected at all. The reference in Section 2.1.3.1 has been deleted.

of construction and operation of the project was also omitted from the draft EIS. The water quality analysis in the final statement should include an assessment of the impacts of the proposed project on the ability of the surface waters of the area to continue to meet water quality standards.

The EIS should address the question of mine dewatering in more detail. Of particular concern to EPA is the quality of this water and the method of disposal. Using waters from the mine pit to control dust on roads could adversely impact surface waters if the mine water is of poor quality. Poor quality mine waters could also have detrimental effects on the environment if used to irrigate revegetated areas. Since waters pumped from the mine pit are considered to be point source discharges, an NPDES permit may be required. A discharge permit for disposal of water used in hydrostatic testing of the product pipeline may also be required.

The quality of mine pit water was presented on page 3-23 and Appendix E of the DES. Water sprayed on roads would evaporate rather than enter surface waters. The infeasibility of irrigating with mine pit water was discussed on page 3-23 of the DES. We acknowledge (and Coteau Properties is aware) that a NPDES permit may be required for discharge of mine pit water,

Frequent references in the EIS to anticipated deterioration of groundwater is disturbing to EPA, especially in regard to the shallow wells and springs that will be impacted by the project. Our concerns about the quality of subsurface waters arise from the impacts of the solid waste disposal methods proposed, the impacts of disrupting the present groundwater relations, and the impacts of deep well injection of wastewater. Our concerns about solid waste disposal are addressed elsewhere in these comments.

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We agree with the concern; however, these impacts were discussed in the EIS (Section 3.1.2.2) and we view these as unavoidable adverse impacts if the project is approved (Section 5.2.2).

The EIS is vague in its analysis of the water quality impacts of disrupting the present groundwater regimes, particularly as these activities will impact the uses or potential future uses of near-surface aquifers for water supply purposes. The final EIS should establish a closer link between the proposed project, its impacts on the quality and quantity of groundwaters, and the effects of those changes on organisms that rely on groundwaters in their present state. Finally, in regard to the deep well disposal of plant effluents, we recommend that ANG be prepared to comply with the forthcoming EPA regulations on deep well injection. These regulations, which are designed to protect existing and potential supplies of fresh water will probably contain both design criteria and operational requirements for deep well disposal, as well as monitoring requirements. Draft regulations (40CFR Part 146) which are presently being revised, were published in the Federal Register on August 31, 1976 (4FR36730).

The DES points out in Section 3.1.2.2 that a lignite aquifer would be destroyed, perched water areas would be dewatered, the quality of water in nearby aquifers could be lowered, that recharge rates would be altered, and that 19 wells and one spring could be affected by mining. We do not consider this analysis "vague" in view of the many uncertainties involved. The deep well injection program is designed to comply with existing EPA policy and ANGCGC will continue to comply with all future applicable Federal, State, and local regulations.

Land Reclamation/Land Use

Post mining land use and reclamation of disturbed areas are vitally important to EPA because they are so closely tied to water quality and the long-term productivity of the land. Our first concern is that nowhere in the EIS is "successful reclamation" defined. Since reclamation means so many things to so many people, we recommend that the term be clearly defined in the final EIS and that the document describe what the mining company's commitment to reclamation is. We realize that the kind of use that reclamation efforts will be aiming toward depends upon the wishes of the surface

"Successful reclamation" would be determined by the North Dakota Public Service Commission. The basic requirements of the PSC regarding reclamation were discussed in Section 4.1.3.

owner, however, we believe that a preliminary survey of the owners' desires should be made and included in the EIS in order to provide at least an approximation of the post-mining land use in the area. In this regard, the question of land ownership assumes importance -- to what extent do energy companies and other corporations already own the surface of areas to be mined? Will the mining company attempt to purchase surface ownership of areas to be mined? To what extent might the kind of surface ownership (i.e. private individual vs private corporation) influence the kinds of reclamation goals and commitments? EPA believes that a project of this magnitude should include plans to mitigate the impacts of the development on wetlands, woodlands and other important ecosystems, even if this requires purchase of surface ownership and reclamation aimed at establishing or restoring these ecosystems or acquisition and protection of replacement lands that might otherwise be threatened by incompatible development.

A survey of landowners' preferences would not necessarily yield an accurate description of final land uses. Surface ownership and owners' desires would certainly change from year to year over the life of the project. The mining company owns a very small percentage of the surface rights (less thant 5 percent) and would have very little control of final land uses. Those lands owned by the company, however, would be reclaimed largely to wetland or wildlife habitat. We know of no statutory authority to require the company to purchase surface rights.

As noted in Sec. 1.5.6.1, segregation of topsoil during pipeline construction may be required by an agency or a landowner. Since most of the pipeline will follow railroad rights-of-way, will the owners or managers (railways) require topsoil segregation and other special treatments?

Since most of the ROW was disturbed years ago by construction of the railroad, it is not anticipated that topsoil segregation would be required or of much value.

In spite of the uncertainty about landowner desires for reclamation, the EIS should address the reclamation potential of the lands in question. Sufficient studies of revegetation have been conducted at other sites in the Northern Great Plains to provide some insight into the potential of the site for crop production and various other uses after mining. These observations would help establish limits within which postulations about reclamation success can be made and could also be useful to the landowner in selecting a post-mining use for the land.

Reclamation potentials were discussed in Section 2.1.4.3 of the DES.

Finally, long-term efforts at soil conservation and crop protection should be planned and begun in the early stages of the project. Wind breaks, for example, could be planted now so that they can provide protection to areas that will be mined and reclaimed in future years. Such plantings could also help to mitigate some of the wildlife habitat losses that are anticipated as a result of the project. The EIS should also address various environmentally sound alternatives for long-term use of the site and facilities following abandonment.

We agree with the suggested soil conservation and crop protection measures and have recommended them to ANGCGC. Condition #5 of the Conditional Use Permit requires that the site be returned to its original condition.

Impacts on Wetlands

The impact of the project on wetlands appears to be quite severe. In addition to destroying nearly 100 acres of prime wetlands at the plant and mine site itself, an unknown amount of wetland area will be disturbed by pipeline construction. We feel that the final EIS should do a better job of describing the impacts of the project on these wetlands and project plans should be modified to do a better job of avoiding or mitigating adverse impacts on wetland habitat. We suggest that wetlands be avoided wherever possible in construction and operation of all phases of

The plantsite has been adjusted slightly to accommodate the Basin Electric powerplant and the 47 acres of wetland would not be disturbed by the gasification plant. The 50 acres of wetland in the mine are minimal for the amount of land to be mined. New data on wetlands near the proposed pipeline route have been added to Section 2.2.2.3 of the EIS.

J-76

the project. Replacement wetlands should also be included in post-mining reclamation plans, even if this necessitates acquisition of surface ownership of some of the lands in question.

Finally, all wetlands and other surface waters should be inventoried and the need for Sec. 404 permits should be assessed. We anticipate that substantially more Sec. 404 permits than the two mentioned in Sec. 4.5.3 will be necessary since the final phase of the Sec. 404 permit program includes all streams with greater than 5 cfs of flow and their adjacent wetlands. The U.S. Fish and Wildlife Service and State fish and game agencies should be consulted about wetland habitat values, mitigation measures, and techniques that can be used to provide replacement habitat.

Only the 47 acre wetland at the original ANGCGC plantsite would have required a Section 404 permit. The proposed Basin Electric powerplant would impact this wetland and they will have to aquire the necessary permit.

Socio-economic Impacts

The discussion of the socio-economic impacts of the proposed project reveals that the study area is already under considerable stress due to existing energy development activities in the region. Judging from the expected influx of people caused by ANG/Basin Electric and the further population growth anticipated with the construction of the Coyote Project and other developments, severe impacts on the socio-economic environment are almost certain to occur. Critical needs fall in all the major sectors of municipal life, including: housing, schools, health care, police and fire protection, recreation facilities, transportation systems, etc. Towns in the impact area may have major difficulties obtaining funds because of the competition for municipal bonds and low bond ratings that potential "boom and bust" communities receive in the municipal bond market.

We agree with this comment and discussed such impacts in Section 3.3 of the DES.

The final EIS should include a concise summary of the existing socio-economic environment, including data and descriptive material on local demography and economics as well as life styles or quality of life aspects of the study area. The discussion of socio-economic impacts should address the impacts of development on both the populace that lived in the study area before energy development and the people who will move to the area because of energy development, as the impacts on these two groups and the appropriate mitigating measures to alleviate the impacts may be different.

The existing socioeconomic environment was discussed in Sections 2.3 and 2.4 of the DES. Impacts to current residents versus immigrants were discussed in Section 3.3.1.4 of the DES.

The final EIS should also address the anticipated benefits of the project on unemployment at the Fort Berthold Indian Reservation, how the company expects to meet its obligations to Mercer county concerning socio-economic impacts under the agreement on rezoning (Sec. 4.5.2), and what planning and front end financing efforts are being undertaken to mitigate ANG's share of the impacts of regional energy development.

Benefits of the project on Indian unemployment were discussed in Section 3.4.1 of the DES. The stipulations to the rezoning permit have been changed and the final stipulations do not require ANGCGC to arrange financing. All planning and front end financing efforts proposed by ANGCGC were included in Section 4.4.1 of the DES.

J-17

Impacts on Cultural Resources

The historical and archaeological resources of the area appear to have been inventoried adequately in the EIS. however, the secondary impacts of development on these resources are not addressed. Even though the project itself may not directly affect these resources, we are concerned that the influx of people into the area and the accessibility of historical and archaeological sites may result in the loss of these resources due to vandalism and the depredations of amateur collectors of archaeological or historic objects. We believe that this problem should be addressed in the final EIS and that effective measures to protect the cultural resources of the area should be implemented.

Since all archaeological and historical sites are on private property and since trespass on this property is restricted, we do not feel that vandalism of these sites will necessarily result because of the proposed project. We know of no measures that the Federal Government can take to preclude private acts of vandalism. The additional potential for vandalism due to additional population has been added to Section 3.4.2.

Alternatives

The discussion of alternative plant sites (Sec. 8.2.1) is extremely confusing because the alternative sites are not precisely identified by location and there appears to be no meaningful correlation between the sites listed in Sec. 8.2.1.a and the sites shown in tables 8-1 through 8-3. At present, it is impossible for readers of the EIS to make meaningful comparisons among alternative sites and draw independent conclusions about any of the alternatives.

See response to this same comment from REA on page J-40.

In discussing alternative energy sources (Sec. 8.4.2) the EIS perpetuates a misleading comparison that is often made between the sulfur contents of eastern and western coals. The comparison between the sulfur content of eastern and western coals is more meaningful when it is based on the energy equivalent of the coals rather than the absolute sulfur content by weight, and thus the difference between the "low sulfur" coal of the west and the "high sulfur" coal of the east diminishes when the lower energy content of western coal is taken into account.

We agree with this comment and have deleted the reference to the low sulfur content of Western coals.

Finally, several alternatives to the project as it is proposed are not discussed even though they could reduce the need for the project and thus alleviate the impacts of rapid energy development in the study area while conserving resources that should be available to future generations. These include such alternatives as greater emphasis on energy conservation, elimination of low efficiency gas applicances and appliances that require continuous pilot lights, and limitations on new customers for gas service. These alternatives are compatible with maintaining a high standard of living while providing for gradual development of energy resources in the primary impact area of the project and enhancing the range of alternative energy uses that will be available to future generations.

The alternative of energy conservation was discussed on page 8-25 of the DES. The other alternatives suggested are simply methods of conserving energy. Limiting new gas customers may conserve natural gas, but does nothing to provide for the energy needs of those persons.

IN HUNTING & FISHING
VARIETY

NORTH DAKOTA GAME AND FISH DEPARTMENT

PHONE - 224-2180

APR 27 8 47 AM '77

OFFICIAL FILE COPY
APR 29 1977
NO REPLY NECESSARY
REPLY OR OTHER ACTION TAKEN
BISMARCK, N. DAK. 58505

FOR YOUR	INITIALS	DATE
450		
415		

April 26, 1977

Mr. Robert L. McPhail
Regional Director
Bureau of Reclamation
P. O. Box 2553
Billings, Montana 59103

J-79

Re: Draft Environmental Statement ANG Coal Gasification Company
Mercer County, North Dakota

Dear Mr. McPhail:

The Game and Fish Department has reviewed the draft EIS on the above project. Following are our comments regarding the same.

Specific Comments:

Pages 2-67 - 2-74 One of the major weaknesses of the sections on birds and mammals is the fact that field studies were conducted from late May to mid-October. As a result, the migratory bird estimates, especially for waterfowl, are low because the majority of the migration occurs prior to late May or after mid-October in this area. Furthermore, the importance of this area for wintering species is not reflected in these figures.

We acknowledge this comment; however, since the field study was designed to gain the maximum amount of information in a reasonable amount of time, it was decided to concentrate on breeding birds and mammals because these populations would be those most affected by the proposed project.

Page 2-70 (2.2.3.1a) To our knowledge there are no records of nesting sandhill cranes in the 49 section study area. In fact, since the early 1920's there has been only one nesting record of sandhills in North Dakota and that occured in 1973 in McHenry County. Sandhill crane use is restricted to resting and feeding during spring and fall migration.

The sentence has been changed to reflect this comment.

Page 2-70 (2.2.3.1b) We question the reliability of the sharp-tailed grouse population density figures. The draft EIS indicates a fall population of 6.7 birds/mi^2 yet Department estimates put the spring breeding population at over 6.0 birds/mi^2 for this area.

A paragraph discussing these data has been added to Section 3.2.2.

Likewise the breeding population of pheasants appear quite low. The draft EIS states a breeding population of 2.4 birds/mi^2, while we estimate the spring breeding population for this area is approximately 10 hens/mi^2.

Page 2-70 (2.2.3.2c) Department population estimates for deer in northern Mercer County are as follows:

whitetails - 0.5-1.5/mi^2
mule deer - less than 0.5/mi^2

Page 2-73 (Table 2-20) The estimated fall populations for coyote and fox are too low. Our census results indicate coyote densities are approximately 0.3 to 0.5/mi^2 and fox densities are 1.0 to 1.3/mi^2 for this area.

Page 2-80 (2.2.5.2) Even though ANGCGC is "committed" to a detailed biological survey of the proposed route before final alignment, this should have been done prior to releasing the draft EIS.

Page 3-22 (3.1.2.1b) This paragraph indicates that 1,500 to 2,000 acres of land will be exposed at any one time, yet on page 3-32 the figure is 2,500 acres. Why the discrepancy? The figures should be consistant.

Page 3-33 (3.2.1.2) The three to five year period given to return mined land to productive agricultural use may be too optimistic. Our experience based on present reclamation activities is that few areas reach their full productivity within this span of time.

Page 3-36 (3.2.1.2b) While it is true that natural communities resembling premining conditions may never be reestablished, a productive plant community consisting of native species can be established.

Page 3-36 (3.2.1.2d) Woodland habitat is critical in this area of the state and every effort should be made to preserve this habitat type. The hardwood draws in particular are for all practical purposes impossible to reclaim and should not be mined. On the other woody cover our standard recommendation for replacement is on a 2:1 basis (2 acres artificial for every 1 acre natural destroyed).

Page 3-37 (3.2.1.3) Where the water pipeline crosses native prairie or hayland, this right of way should be reseeded to similar species to lessen the chances of undesirable species invading this area.

Page 3-38 (3.2.1.5a) Again where the product pipeline crosses rangeland, pastureland or hayland this right of way should be reseeded in kind.

Page 3-38 (3.2.1.5c) Approximately how many wetland basins are represented in the 22 miles of pipeline?

Page 3-46 (3.2.2.6) It should be pointed out that marsh hawks nest in more than wolfberry thickets. It is doubtful whether this will be a limiting factor for them.

J-80

See response to above comment.

See response to above comment.

The final alignment of the pipeline will not be made for several years, thus a detailed biological survey could not be included in the EIS. However, a general corridor study was conducted to provide data for the EIS.
The 2,500 acres refers to land out of agricultural use; some of the land may have vegetative cover, but not be reclaimed enough for release by the PSC.

The 3 to 5 years refers only to cropland; about 10 years would be required for return to rangeland. References supporting these estimates have been added to the text.

We agree with this comment and indicated so in the discussion on reclamation (Section 4.2.4).

We agree that native woodland habitat should not be mined whenever possible; however, only 29 acres of scattered native woodlands would be disturbed by this project and it is not possible to mine around these scattered tracts.

We agree with this comment and ANGCGC has agreed to reseed as suggested if the appropriate seed is available.

See response to above comment.

About 155 wetland basins are close to the railroad ROW.

The paragraph has been changed to reflect this comment.

Appendix H (Pages 1-3) Based on our data, the estimates given for individual species are excessively low, especially the game species. For example, according to this report, only 30 grouse are found on the 12,500 acre mining area. Our data indicates this is a high density sharptail area with a minimal breeding population of over 6.0 sharptails/mi^2. Based on these data, the spring population is approximately 120 birds or four times higher than indicated. When reproduction is calculated, this further expands this number.

A paragraph discussing the data presented in this letter has been added to Section 3.2.2.2.

Likewise, pheasant, fox, coyote, deer and antelope estimates, to mention a few, appear to be low. We suggest more reliable data on the game species be presented in this report.

See response to above comment.

General Comments

The end result of the proposed action on fish and wildlife resources will likely be one of negative impacts. The permanent alteration of wildlife habitat, the unknowns of air and water quality and the rapid influx of workers into Mercer County are certain to result in reduced wildlife populations and recreational opportunities. The long-term cumulative affects of this and other energy development proposals in this vicinity could result in these losses being of statewide significance.

We agree with this comment and have included these impacts in the EIS.

J-81

Perhaps one of the most disturbing factors in this entire endeavor is the fact that there are absolutely no guarantees that "mitigating measures" will be carried out. The draft EIS points out that post-mining land use will be at the discretion of the land owner and very likely the majority of the grassland acres will be converted to cropland use. Furthermore, in the discussion on the plant facility and product pipeline the report indicates mitigation measures will be geared to "unnecessary habitat destruction".

State of North Dakota laws and regulations confer such descretion to the landowners.

Our position is similar to the one stated on page 3-46:

> "Unless mined land is reclaimed specifically for wildlife values, the reclaimed land actually provides very little for wildlife compared to minimal or, in some cases, no reclamation. Unreclaimed or partially reclaimed land from previous mining operations in North Dakota often supports native vegetation, much of it woody, wetland areas, and is relatively inaccessible to humans. Such areas currently provide important winter cover and relatively undisturbed refuges for wildlife."

No response necessary.

We too are of the opinion that unless some areas are managed specifically for wildlife purposes, the project will result in a net loss for wildlife. Our recommendation is that consideration be given to actually

replacing wildlife habitat destroyed as a result of project action including the plant facility, mine and product pipeline. We believe through careful planning it would be possible to develop a mutually acceptable habitat plan and in turn minimize the overall impacts. We welcome the opportunity to discuss the matter further with ANGCGC representatives.

Thank you.

Sincerely,

Russell W. Stuart
Commissioner

RWS/jg

cc: Public Service Commission
Riverdale District Office (Enyeart)
District Warden, Hazen (Burkett)

J-82

This suggestion has been passed on to ANGCGC. As much as we sympathize with the desire to preserve wildlife habitat, we know of no legal basis for requiring privately owned land to be devoted to that purpose.

NORTH DAKOTA STATE PLANNING DIVISION

STATE CAPITOL—FOURTH FLOOR—BISMARCK, NORTH DAKOTA 58505
701 224-2818

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May 9, 1977

STATE INTERGOVERNMENTAL CLEARINGHOUSE "LETTER OF COMMENT"
ON PROJECT REVIEW IN CONFORMANCE WITH OMB CIRCULAR NO. A-95

To: U.S. Department of Interior - Bureau of Reclamation

STATE APPLICATION IDENTIFIER: 7703287329

Mr. Robert L. McPhail
Regional Director
U.S. Department of Interior
Bureau of Reclamation
P.O. Box 2553
Billings, Montana 59103

Dear Mr. McPhail:

Subject: Draft Environmental Impact Statement by the Bureau of Reclamation on ANG Coal Gasification Company's proposed coal gasification complex in Mercer County, North Dakota.

This Draft EIS was received in our office on March 28, 1977.

In the process of the A-95 review, the attached comments were received from the Attorney General, Regional EIS, ND Geological Survey, ND Park State Health Department and the ND Highway Department.

This document and attachments constitute the comment of the State Intergovernmental Clearinghouse, made in compliance with OMB Circular No. A-95. The ND State Intergovernmental Clearinghouse requests the opportunity for complete re-review of applications for renewal or continuation grants or applications not submitted to or acted on by the funding agency within one year after the date of this letter.

Sincerely yours,

Bonnie A. Banks
Mrs. Leonard E. Banks
Associate Planner

LEB/ds

Attachment

No response necessary.

NORTH DAKOTA STATE PLANNING DIVISION

STATE CAPITOL—FOURTH FLOOR—BISMARCK, NORTH DAKOTA 58505
701-224-2818

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O REPLY NECESSARY — Initial — Date

...W OR OTHER ...ATION TAKEN — Code No. — Date

...TY TO: 160

May 16, 1977

STATE INTERGOVERNMENTAL CLEARINGHOUSE SUPPLEMENTARY "LETTER OF COMMENT" ON PROJECT REVIEW IN CONFORMANCE WITH OMB CIRCULAR NO. A-95

To: U.S. Department of Interior - Bureau of Reclamation

STATE APPLICATION IDENTIFIER: 7703287329

Mr. Robert L. McPhail
Regional Director
U.S. Department of Interior
Bureau of Reclamation
P.O. Box 2553
Billings, Montana 59103

I-84

Dear Mr. McPhail:

Subject: Draft Environmental Impact Statement by the Bureau of Reclamation on ANG Coal Gasification Company's proposed coal gasification complex in Mercer County, North Dakota.

This Draft EIS was received in our office on March 28, 1977.

In the process of the A-95 review, the attached comments were received from the Regional EIS Office, Mr. John E. Velehradsky, Ms. Arlene Wilhelm, Mr. Ted Nace and United Plainsmen Association.

This document and attachments constitute the further comment of the State Intergovernmental Clearinghouse, made in compliance with OMB Circular No. A-95. Previous comments were received with a "Letter of Comment" dated May 9, 1977.

Sincerely yours,

Mrs. Leonard E. Banks
Associate Planner

LEB/ds

Attachments

All of the comments attached to this letter were received previously in the letter from the BLM-North Dakota Regional EIS Team or during the public hearings in Beulah and Bismarck and are addressed in those sections.

NDSIC FORM B (9/71)

PNRS NO.
77-324
Date Received

FROM: STATE INTERGOVERNMENTAL CLEARINGHOUSE
STATE PLANNING DIVISION
STATE CAPITOL
BISMARCK, NORTH DAKOTA 58501

ENVIRONMENTAL IMPACT STATEMENT TO BE REVIEWED

TO: Allen I. Olson
Attorney General

RECEIVED APR 11 1977 State Planning Division

ISSUED BY: DOI - Bureau of Reclamation

DATE: March 30, 1977

NAME OF PROJECT: D-EIS: ANG Coal Gasification Company

The attached Environmental Impact Statement is referred to your agency for review and possible comments. ~~If you consider it satisfactory~~, please check the box labeled, "no comment." Otherwise, please check one of the other appropriate boxes. Your cooperation is asked in completing this memo and returning it to the State Intergovernmental Clearinghouse within 10 days from date of receipt. If no response is received within 15 days of date of notification it will be assumed you have no comment.

☒ No comment This is not an indication that the Attorney General's office considers the EIS to be "satisfactory". ☐ Meeting desired with applicant
☐ Comments submitted herewith It simply indicates that no comment will be made at this time.

J-85

No response necessary.

1. Specific comments which are to be attached to the review statement which will be submitted by the State Intergovernmental Clearinghouse: (Use reverse side or separate sheets if necessary)

2. Reasons why meeting is desired with applicant:

Reviewer's Signature: Shirley J. Spading Smith Date: 4-7-77

Title: Assistant Attorney General - Natural Resources Section Tele: 224-2712

NDSIC FORM B (9/71)

PNRS NO.
77-329
Date Received

FROM: STATE INTERGOVERNMENTAL CLEARINGHOUSE
STATE PLANNING DIVISION
STATE CAPITOL
BISMARCK, NORTH DAKOTA 58501

ENVIRONMENTAL IMPACT STATEMENT TO BE REVIEWED

TO: Dr. Gary Johnson
Regional EIS

RECEIVED
APR 14 1977
State Planning Division

ISSUED BY: DOI - Bureau of Reclamation

DATE: March 30, 1977

NAME OF PROJECT: D EIS: ANC Coal Gasification Company

The attached Environmental Impact Statement is referred to your agency for review and possible comments. If you consider it satisfactory, please check the box labeled, "no comment." Otherwise, please check one of the other appropriate boxes. Your cooperation is asked in completing this memo and returning it to the State Intergovernmental Clearinghouse within 10 days from date of receipt. If no response is received within 15 days of date of notification it will be assumed you have no comment.

J-86

☐ No comment

☐ Comments submitted herewith

☐ Meeting desired with applicant

☒ Comments will be forwarded directly

1. Specific comments which are to be attached to the review statement which will be submitted by the State Intergovernmental Clearinghouse: (Use reverse side or separate sheets if necessary)

Comments will be coordinated with BLM Billings office and forwarded directly to Bureau of Reclamation.

2. Reasons why meeting is desired with applicant:

Reviewer's Signature: Gary Johnson Date: 4-12-77

Title: State Assistant Planner

Tele: 3141

See letter of comment from BLM.

NDSIC FORM B (9/71)

PNRS NO.
77-329
Date Received

FROM: STATE INTERGOVERNMENTAL CLEARINGHOUSE
STATE PLANNING DIVISION
STATE CAPITOL
BISMARCK, NORTH DAKOTA 58501

ENVIRONMENTAL IMPACT STATEMENT TO BE REVIEWED

TO: Mr. Erling Brostuen
ND Geological Survey
Grand Forks, ND 58201

ISSUED BY: DOI - Bureau of Reclamation

DATE: March 30, 1977

NAME OF PROJECT: D EIS: AN[illegible] Coal Gasification Company

The attached Environmental Impact Statement is referred to your agency for review and possible comments. If you consider it satisfactory, please check the box labeled, "no comment." Otherwise, please check one of the other appropriate boxes. Your cooperation is asked in completing this memo and returning it to the State Intergovernmental Clearinghouse within 10 days from date of receipt. If no response is received within 15 days of date of notification it will be assumed you have no comment.

J-87

☐ No comment
☒ Comments submitted herewith
☐ Meeting desired with applicant

1. Specific comments which are to be attached to the review statement which will be submitted by the State Intergovernmental Clearinghouse: (Use reverse side or separate sheets if necessary)

Comments are attached.

2. Reasons why meeting is desired with applicant:

Reviewer's Signature: Erling A. Brostuen Date: April 11, 1977

Title: Geologist Tele: 777-2231

Comments on draft EIS: ANG Coal Gasification Company.

Section

1.5.5.2 Where will the 5 million cu. ft. pond be located? An unlined pit located on the Beulah Trench could cause pollution problems due to permeability of soil and surface materials.

The pond would be located in the south or southeastern portion of the plantsite. The pond would contain relatively clean stormwater runoff and would be lined to minimize seepage.

2.1.3.1c Will the brine designated for deep well injection be compatible with formation fluids and materials?

The brine would be compatible with fluids and materials in the Minnelusa and Dakota formations.

3.1.2.2c No data is presented to support preliminary statement that mine pit sealing is unnecessary.

This was ANGCGC's position based upon a Woodward-Clyde report dated November 14, 1975. The report can be made available to your agency upon request to ANGCGC. We, however, do not believe that a definite decision can be made regarding migration of leachates into adjacent aquifers based upon available data; ANGCGC is still studying the problem.

The movement of leachate from buried ash and sludge is a distinct possibility. Many of the salts and trace elements are highly soluble. The absence of carbonaceous material which originally retained the salts and trace elements may result in their lateral movement into adjacent aquifers.

The quantity of sludge to be disposed of is not given. I assume that it is in addition to the 90 T/hr. figure given for ash disposal.

About 30 gpm of evaporator concentrate would be disposed of in the mine. This would be in addition to the ash.

The feasibility of recovering some of the valuable or hazardous trace elements should be considered. As an example, the ppm. concentration of uranium is low, but 26.9 lbs./day is a considerable amount to dispose of into the mined area. Inasmuch as the lignite has been mined, burned and the uranium concentrated in the ash, the cost-benefit ratio of additional processing to extract the uranium may be economically acceptable.

Recovery of the relatively small quantities of materials would require extensive processing which makes the concept economically unfeasible at this time.

4.1.2.2 This statement does not consider the possible effect of leachate from buried solid waste on ground water.

The statement assumes corrective action would be taken if leachate movement is detected in the monitoring wells.

Preliminary studies are frequently referred to but are not supported by data.

Detailed data will be provided to your agency through ANGCGC upon request.

J-88

NORTH DAKOTA PARK SERVICE
FORT LINCOLN STATE PARK
ROUTE 2 BOX 139
MANDAN, NORTH DAKOTA 58554
PHONE 663-9571

April 20, 1977

Bonnie Banks
State Planning Division
State Capitol
Bismarck, ND 58505

Dear Mrs. Banks:

The following comments deal with recreation aspects of the Draft Environmental Impact Statement for ANG's proposed gasification plant, prepared by the Bureau of Reclamation. In September, 1975, I commented on a draft environmental report for the project (letter attached). In October, 1976, we commented again on the preliminary D.E.S. (letter attached). Several concerns were raised in both letters and were not addressed adequately in this draft E.I.S. In general, I find the socio-economic sections of this report need strengthening.

J-89

Indoor recreation is still my main concern. The social impact of added population would be lessened if indoor recreation facilities and programs were adequate. As the E.I.S. states on page 3-73 - Private entrepreneurs would likely fill some demands. Publicly funded facilities and programs are the major concern, however. ANG inventoried indoor facilities near the proposed site in 1976. Although a list of facilities would not be necessary in the E.I.S., a general evaluation of how well they now meet community needs should be made. How crowded are these facilities? Are towns planning to expand their facilities or programs? A few telephone calls would give authors a more accurate picture of indoor recreation needs.

The attached letters refered to the Woodward-Clyde Report, and a preliminary draft of the DES that were circulated to other agencies to define areas of concern. The comments received were incorporated as much as possible, and the remainder of the original comments are not applicable to the DES and are not included.

The discussion in Section 2.3.3 points out that private (including indoor) recreation facilities are limited; this would indicate that they are overcrowded. Impacts to indoor recreation facilities were discussed in Section 3.3.2.7. The towns would like to expand indoor recreation programs and facilities, but financing is a problem in view of all the other coal-related demands. We believe many impacts on indoor recreation in rural communities are self-evident and lengthy discussions are not required.

After school and summer use of school gymnasiums should be investigated, and suggested as a mitigating measure. A discussion of needs for public libraries was also missing from the three drafts, and should be included in the final E.I.S. Adequate library facilities and books would also mitigate social and recreation impacts. Both of these suggestions have been previously offered.

The use of school gymnasiums would help alleviate impacts but would not be "mitigation" provided by ANGCGC. Libraries were considered education needs and the discussion of education impacts and needs includes libraries.

The impact of added people on public hunting lands was not discussed. As stated in my October, 1976 B.L.M. letter "Game and Fish Department personnel anticipate upland game hunting would be most affected by the project through habitat loss and by increased hunting pressure. At Sakakawea, walleye fishing is improving while northern pike fishing is declining due to habitat loss." Man-days of outdoor recreation is available for the last few years for Hille Game Management Area (nearest the project). 1974 figures are found on page 2 of the October, 1976 letter.

The impact of added people on public hunting lands was discussed on page 3-46 of the DES; the effects of habitat loss on wildlife was discussed in Section 3.2.2.6. The proposed project would not affect northern pike habitat. The effect of increased population on the Hille Game Management Area was discussed on page 3-73 of the DES.

Needs for recreation facilities (page 3-74) were calculated using minimum standards established by our agency in 1970. This method is a common, easy one, but has many shortcomings. We hope, in the Regional E.I.S., to describe a better method for calculating these needs.

I hope these suggestions and those in the attached letters are helpful.

Sincerely yours,

Karen F. Thompson
Recreation Planner/Analyst
State Parks & Recreation Department &
Regional Environmental Impact Statement

KFT/kmm
Enclosures

J-90

No response necessary.

NDSIC FORM B (9/71)

PNRS NO. 77-329
Date Received

FROM: STATE INTERGOVERNMENTAL CLEARINGHOUSE
STATE PLANNING DIVISION
STATE CAPITOL
BISMARCK, NORTH DAKOTA 58501

ENVIRONMENTAL IMPACT STATEMENT TO BE REVIEWED

RECEIVED MAY 3 1977 State Planning Division

TO: WILLIS VAN HEUVELEN
STATE HEALTH DEPARTMENT
STATE CAPITOL
BISMARCK ND 58505

662

ISSUED BY: DOI - Bureau of Reclamation

DATE: March 30, 1977

NAME OF PROJECT: D EIS: ANG Coal Gasification Company

J-91

The attached Environmental Impact Statement is referred to your agency for review and possible comments. If you consider it satisfactory, please check the box labeled, "no comment." Otherwise, please check one of the other appropriate boxes. Your cooperation is asked in completing this memo and returning it to the State Intergovernmental Clearinghouse within 10 days from date of receipt. If no response is received within 15 days of date of notification it will be assumed you have no comment.

☐ No comment

☐ Meeting desired with applicant

☒ Comments submitted herewith

1. Specific comments which are to be attached to the review statement which will be submitted by the State Intergovernmental Clearinghouse: (Use reverse side or separate sheets if necessary)

(See attached sheets)

2. Reasons why meeting is desired with applicant:

Reviewer's Signature: W Van Heuvelen Date: April 27, 1977

Title: Chief, Environmental Control Tele: 224-2371

415

840.

JUL 1 1977

Gene A. Christianson, P.E.
Division of Environmental Engineering
North Dakota State Department of Health
1200 Missouri Avenue
Bismarck, North Dakota 58501

Dear Mr. Christianson:

Thank you for your comments on the ANG Coal Gasification Company Draft Environmental Statement. As agreed during your recent telephone conversation with Mr. Crase of my staff, we are enclosing a copy of ANG's responses to your comments. In addition, your comments as provided through the BLM-North Dakota Regional EIS team, as well as the appropriate responses, will be included in the final statement.

If you have any questions regarding this matter, please contact Dean Loomis or Fred Crase at (406) 657-6605.

Sincerely yours,

DENNIS E. SCHROEDER

for James A. Rawlings
Regional Supervisor
Division of Water and Land

Enclosure

bc: 415

The comments refered to in the third sentence were nearly identical with the comments submitted directly by the Department of Health.

NDSIC FORM 1 (9/71)

PNRS NO.
77-329
Date Received

RECEIVED
MAY 4 1977
State Planning Division

FROM: STATE INTERGOVERNMENTAL CLEARINGHOUSE
STATE PLANNING DIVISION
STATE CAPITOL
BISMARCK, NORTH DAKOTA 58501

ENVIRONMENTAL IMPACT STATEMENT TO BE REVIEWED

TO: Mr. Robert Bradley
ND Highway Department

ISSUED BY: DOI - Bureau of Reclamation

DATE: March 30, 1977

NAME OF PROJECT: D EIS: ANG Coal Gasification Company

J-62

The attached Environmental Impact Statement is referred to your agency for review and possible comments. If you consider it satisfactory, please check the box labeled, "no comment." Otherwise, please check one of the other appropriate boxes. Your cooperation is asked in completing this memo and returning it to the State Intergovernmental Clearinghouse within 10 days from date of receipt. If no response is received within 15 days of date of notification it will be assumed you have no comment.

☐ No comment

☐ Meeting desired with applicant

☒ Comments submitted herewith

1. Specific comments which are to be attached to the review statement which will be submitted by the State Intergovernmental Clearinghouse: (Use reverse side or separate sheets if necessary)

See Attachments

2. Reasons why meeting is desired with applicant:

Reviewer's Signature: R.E. Bradley Date: May 2, 1977

Title: Chief Engineer Tele: 224-2584

NORTH DAKOTA STATE HIGHWAY DEPARTMENT
Comments on Bureau of Reclamation
Draft EIS "ANG Coal Gasification Company"
April 28, 1977

The statement gives only a cursory reference to impacts on state and local road systems in Section 1.5.2, 1.5.4.1 and 3.3.2.6. The report does mention access to the plant site and also to the pipeline construction areas.

Historically in similar situations of industrial plant construction a very large percentage of the construction materials are delivered by truck on the highway systems rather than by rail.

In this entire area the local roads or bridges are not constructed in a manner or to a standard that will carry this expected increased traffic volume or increased truck weights.

The statement should include enough of an in-depth study of the existing road systems and projected traffic volumes both in light vehicles and heavy trucks, the construction and maintenance needs and the resultant costs should be included. It is certain that any such study would disprove the accuracy of the statement "it is not likely that the increase in local traffic would require additional funds for public highway construction and maintenance." The study should include the highway user costs of all routes that might be closed or lengthened such as the indirection that would be involved in the relocation of County Road 13 through the plant site.

Using the Snake Creek embankment as the location of the Great Lakes Transmission Line is of great concern from a safety standpoint.

Placement of the pipeline between the railroad and highway will require closing two lanes of traffic on U.S. 83 during construction. The pipeline will be very close to the shoulder of the roadway. If the pipeline should explode or rupture there would be the possibility of serious effects on public safety.

We have previously commented on Environmental Impact Statements for both the Coal Gasification Plant and Transmission Pipeline, copies of our comments on the previous statements are attached.

J-93

Section 3.3.2.6 described increased traffic, the need to resurface existing roads, and destruction of secondary roads.

As discussed on pages 1-67 and 3-71 of the DES, present estimates indicate that about 90 percent of the construction materials would be brought in by rail.

See response to above comment.

The "In-House Planning Overview Report" prepared by the North Dakota State Highway Department included traffic data for the proposed gasification plant and powerplant provided by ANGCGC. Conclusions in Section 3.3.2.6 were drawn partially from that report which is cited in the bibliography.

We do not believe there is a significant hazard, but it is discussed in Section 3.3.2.3.

The attachments referred to copies of the Woodward-Clyde Report, and a preliminary draft of the DES that were circulated to other agencies to define areas of concern. The comments received were incorporated as much as possible, and the remainder of the original comments are not applicable to the DES, thus the attachments are not included.

REGIONAL ENVIRONMENTAL ASSESSMENT PROGRAM
Resources Environment Knowledge People — The Future
316 North Fifth Street, Room 521 - Bismarck, North Dakota 58505
Telephone (701) 224-3700
A. William Johnson, Director

REAP MAY 13 AM

MAY 31 1977

Initial

May 17, 1977

ACTION TAKEN

Code No.

INFO. COPIES TO:

480

415 L-7 5/19

Mr. Robert L. McPhail
Regional Director
Bureau of Land Management
P.O. Box 2553
Billings, Montana 59103

Dear Mr. McPhail:

J-94

I wish to make the following concerns a part of the record in order that these be appropriately addressed by those responsible for the final environmental impact statement on the ANG Coal Gasification project.

I have examined the table included in Section 2.1.4.5, the 1975 land use within Mercer County. The North Dakota Regional Environmental Assessment Program has just completed a computer categorization of land cover of the entire state, using LANDSAT imagery. The land cover acres for Mercer County do not agree with those included in the draft impact statement. While there are some assumptions in the REAP data, there is no explanation for the approximately 40 percent fewer acres of water reported by the NDSU source. This is one category which is most accurately assessed through the LANDSAT technique. Adding another more than 10,000 acres of wetlands (present in 1975) merely compounds the error. What I suggest is that the NDSU source be questioned further or that the new REAP data be submitted.

We realize that different methods of gathering land use statistics will come up with somewhat different data; wetlands would be the most variable statistic depending on the weather prior to data gathering. However, differences in land use data for Mercer County as a whole would not change the impact analysis as use of land to be disturbed by the proposed project was based on on-site surveys of the various areas.

The second point I wish to make concerns the evaluation of historical and archaeological sites. REAP now has the most current identification and documentation of such sites in North Dakota and examination of the records in our files indicates additional sites not shown on the map on page 2-98. In addition, the draft statement neglects fossil sites completely; REAP also has the most complete list of these sites. Whereas the State Historical Society has approximately five such sites for North Dakota, REAP has now compiled 1,225 paleontological sites. It is urged that reference be made to this new information and that consideration of the possible impact of the project on these sites be included.

As mentioned in Section 2.4.3, ANGCGC and Great Lakes have made commitments to conduct detailed surveys of the areas affected by their project before any actual disturbance takes place. These surveys will be reviewed by the North Dakota Historic Preservation Officer. ANGCGC contacted REAP and found that no paleontological sites were known at the plant-mine site; Great Lakes will make the same inquiry regarding the product pipeline once the final alignment is set (Great Lakes, August 19, 1977).

If REAP can be of any assistance, please call on us.

Very truly yours,

John R. Reid

John R. Reid, Ph.D.
Associate Director

JRR:amb
cc: Dr. A. William Johnson
Ms. Bonnie Banks

No response necessary.

J-95

State Historical Society
of north dakota LIBERTY MEMORIAL BUILDING

December 2, 1977

Bureau of Reclamation
Attention: Code 415
P.O. Box 2553
Billings, Montana 59103

Re: Review comments on: "ANG Coal Gasification Company, North Dakota Project, Draft Environmental Impact Statement," U.S.B.R., March 17, 1977.

Dear Sirs:

The State Historic Preservation Office of North Dakota has reviewed the above referenced document and offers the following comments:

J-96

Page 2-96: Since the issuance of the document cultural resources surveys have been contracted and partially completed; the plant site, water pipeline, railway spur and mining areas have been surveyed and all were found to contain archeological resources. The product pipeline survey is in an initial stage of work. The product pipeline projected route will cross several sites with either National Register of Historic Places potential or nominations in process.

Page 2-97: Since the issuance of the document:

Item: 1 Mitigation of one site has been completed; testing and evaluation of the remaining two cultural resources sites in the area are under contract and in process.

Item 2: The intensive field survey of the mine areas has been completed; the raw data is now available, the report is to be completed in the near future; mine areas 1, 2, 3 & 4 have been included in the survey project under contract with ANG and Basin Electric.

Item 3: The water pipeline and railway spur routes have been surveyed and will be included in the final survey report.

The cultural resources surveys completed to date identified 140 archeological and historic sites in the plant, mine, water pipeline and railway spur areas. The majority of the identified sites are circular stone alignment sites (tipi

Much of the data provided in this letter concerns developments after the draft statement was issued and after the cutoff date for the data base used in the FES (September 1, 1977). However, we have included as much of the data in the final statement as possible. As discussed on pages 2-96 and 2-97, work is continuing on surveying and mitigating losses to cultural resources in conjunction with the North Dakota Historical Society and it was not possible to include all the more recent data in the final statement. An independent consulting firm is under contract to provide an archeological survey of the product pipeline route, and the State Historical Society (SHS) will be consulted for evaluation and mitigation of impacts to all sites, including potential and existing National Register sites. In consultation with the SHS, it was agreed that the several years before pipeline construction allows adequate time for the FPC to afford the Advisory Council on Historic Preservation an opportunity to comment on impacts to National Register sites and on the proposed mitigation measures. The Bureau of Reclamation has called the attention of the FPC to the fact that consultation with the Advisory Council will be required when pipeline construction details are firmed up.

rings). The turtle effigy reported in the 1974 survey is of questionable validity; the Voegle Petroglyph is outside the project area and had been stolen prior to the 1976 field project.

Page 2-99, Table 2-39: Corrections and additions

- Line 1: Add 32ME2; the site includes two historic forts, one village site and an Indian Cemetary. It is a "State Historic Site."

  Line 3: Add Connelly Site

  Line 6-7: Both the Blasky and Fordville mound groups are presently considered to be part of one site complex (the correct name is "Fordville Mound Group"). This site has a high research potential and is currently being nominated to the National Register of Historic Places. Site Number: 32WA1.

  Lines 8,9,10,11,12,17 & 18: All of these sites have a medium to high research potential.

  Line 10: Add 32ME4; the correct name is "Alderin Creek Site."

  Lines 13 & 14: 32ME8 and 32ME9 are several miles away from the project area; they will not be affected by the project and should be deleted from this listing. Both still exist in part.

  Lines 15,16,19,21,22,23 and 24: We presume that numbers and evaluations would be available for these sites if locational data were provided to this office.

  Line 20: No such site exists; this is considered to be part of the Fordville Mound Group, 32WA1.

Page 2-100, paragraph 3:
Fordville and Blasky are considered to be one site; see Table 2-39 comments.

Page 3-78, section 3.4.2, paragraph 1:
Documentation for the suggestion that 8 sites located will not be affected in a major manner should be given; does this imply that areas will be actively protected from major and ancillary facility construction and use? The plant colony mentioned here (line 5) is not relevant to this section. Lines 6-7: 140 cultural resources sites are now known to exist in the plant-mine area.

J-97

This information has been added to Table 2-39.

This site has been added to Table 2-39.

These corrections have been added to Table 2-39.

Table 2-39 has been corrected.

Table 2-39 has been corrected.

These sites were deleted from Table 2-39.

Locational data has been provided to the State Historical Society by ANGCGC but are not included in the final statement because the cutoff date for data in the EIS was September 1, 1977.

The site has been deleted.

The paragraph has been corrected.

The paragraph (page 3-79) has been revised to clarify that the eight sites may be disturbed; however, the degree of disturbance is not known at this time. The unique plant community may be considered a cultural resource in line with the National Heritage Program currently under study.

Page 3-78, section 3.4.2, paragraph 2, lines 6-8:
There is no evidence to support the contention that these sites do not continue to exist in the railway right-of-way. Some of the features associated with Plains Village tradition sites have been recorded to a depth of more than 10 feet. Lines 11-13: If the pipeline follows the railway right-of-way through the Fort Clark State Historic Site complex, burials will almost certainly be disturbed.

This sentence refers to surface sites. The discussion in Section 4.4.2 points out that if any underground artifacts are discovered, work will be halted and the State Historic Preservation Officer notified. Lines 11-13 point out that burials may be disturbed. If burials are unearthed the pipeline could be rerouted slightly to avoid the site.

Page 3-79. section 3.6:
No mention is made of indirect adverse impact on cultural resource sites. Such impacts as vandalism resulting from increased awareness and activity in the area should be considered.

This impact has been added to page 3-80 of the FES.

Thank you for your consideration of these comments.

Sincerely,

James E. Sperry
State Historic Preservation Officer
(North Dakota)

C.L. Dill
Survey Archeologist

CLD/je

J-96

MINNESOTA HISTORICAL SOCIETY
Fort Snelling Branch (Building 25), Fort Snelling, St. Paul, Minnesota 55111 • 612-726-1171

19 April 1977

Regional Director, Attention: 415
Upper Missouri Region
Bureau of Reclamation
P.O. Box 2553
Billings, Montana 59103

Dear Gentlemen:

RE: ANG Coal Gasification Company
North Dakota Project

In reviewing this project I find no reference to possible impacts that the gas pipeline may have on cultural resources in Marshall County, Minnesota, or to our letter of November 3 outlining our concerns and recommendations. I have attached a copy of this letter for your information. I see no reason to change our comment.

Sincerely,

Charles W. Skrief
Environmental Assessment Officer

CWS/fr
Encl.

J-99

A discussion of impacts to cultural resources in Marshall County, Minnesota, was made on page 3-78 of the DES. It was in response to your letter of November 3 that we elicited a commitment from Great Lakes to conduct a detailed survey of the entire pipeline route, including that portion of the route in Marshall County, Minnesota, before construction.

770.
GARRISON

MINNESOTA HISTORICAL SOCIETY
Fort Snelling Branch (Building 25), Fort Snelling, St. Paul, Minnesota 55111 • 612-726-1171

215 EH 11/9
415 DW 11/9
400 DES 11/9

3 November 1976

Mr. James M. Verzuh
Regional Director
United States Department of the Interior
Bureau of Reclamation
Upper Missouri Region
P.O. Box 2553
Billings, Montana 59103

J-100

Dear Mr. Verzuh:

RE: Great Lakes Gas Transmission Company
Marshall County

The proposed pipeline will have no effect on any known archaeological site (either historic or prehistoric) in the State of Minnesota. Furthermore, we do not feel that there are any historic archaeological sites in the pipeline right-of-way which might as yet be unknown.

The only systematic archaeological survey conducted in Marshall County of which we are aware was a shoreline survey of the Snake River. The survey was conducted for the Corps of Engineers by Dr. Richard Lane, St. Cloud State University. This covered a strip of land about 50 feet wide on either side of the main channel.

Lane's survey does not enlighten us as to the possible distribution of prehistoric sites in Marshall County but it is interesting in that of the 30 sites or "activity area/zones" found, only two had been previously recorded, a fact which clearly documents the inadequacy of our current records regarding prehistoric archaeological sites (at least in Marshall County). The fact that the pipeline will not affect known sites in Marshall county, therefore, means little at this point.

It is my understanding that the Great Lakes Transmission Company has agreed to halt construction should prehistoric or historic archaeological sites be encountered and to notify the State Historic Preservation Officer. This is laudable, but we question the ability of construction personnel to identify archaeological sites. Therefore we feel that a better means of identification would be to conduct an archaeological survey prior to the commencement of construction.

Great Lakes has agreed to conduct a survey. (See reference on page 2-96 of the DES to Great Lakes' letter dated November 11, 1976).

This office does not feel that the entire route need be examined. Experience up to this point suggests that most prehistoric sites in the midwest are associated with permanent bodies of water, extinct or extant. Few sites lie more than 1000 feet from the edge of a body of water. In Marshall County, areas where prehistoric sites are likely to be found include areas adjacent to extant creeks and rivers, and beach features associated with glacial Lake Agassiz. We feel that at least the following portions of pipeline route should be examined:

Section	Twp.	R	
1	154	50	Stream crossing
6	154	49	Snake River crossing
1, 2, 3	154	48	Pipeline passes near Snake River
33	155	47	Snake River crossing
14, 15, 21, 22	155	46	Stream and River crossings
20, 21, 27, 28	155	45	Snake River crossing, glacial lake Beach ridges
31, 32	155	44	Glacial lake beaches and back swamps

J-101

We are not precisely certain of the route of the last several miles of the pipeline -- however, it would appear that at least one more set of beach ridges should be investigated to the east of the last location.

We also note that most of the pipeline will be placed within the existing railroad right-of-way. There is a very good chance that prehistoric archeeological sites that were crossed by the railroad may already be so thoroughly disturbed that the pipeline construction will have little additional impact, obviating the need for mitigation, and, perhaps also the need for a survey. These decisions should be made by a qualified archaeologist only after visual inspection of the area.

There are no sites of historic or architectural significance on or eligible to the National Register in the project area.

Thank you for your attention to cultural resources in your planning process.

Sincerely,

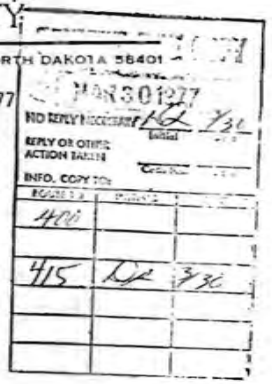
Charles W. Skrief

CWS/fr

EIS B261

North Dakota | NATURAL SCIENCE SOCIETY
BOX 1672
JAMESTOWN, NORTH DAKOTA 58401

March 28, 1977



Regional Director, Attn: 415
Upper Missouri Regional Office
Bureau of Reclamation
P. O. Box 2553
Billings, Montana 59103

Dear Sir:

We have briefly reviewed the draft EIS on the ANG Coal Gasification Complex in Mercer County, North Dakota.

J-102

The draft statement appears suitable. However, we urge that studies of the long-term effects of plant emissions on the human environment be completed before construction is authorized. We are particularly concerned about fallout of toxic metals and the harmful effects of synergistic gaseous byproducts. To answer these questions, laboratory experiments with small-scale Lurgi pressure gasifiers using North Dakota lignite should be considered.

We agree that long-term studies are desirable; we believe they are more properly the responsibility of the national health agencies, EPA, or ERDA. It has been suggested to ANG that they monitor human health in the area over the long term.

Additional plants of this type have been proposed for western North Dakota. Therefore we feel that a dangerous potential for cumulative adverse impacts exists. Until the companies reveal their long-term plans for gasification plants and other energy-related facilities, a single impact statement on a single facility will not fulfill the public need.

We agree with this comment; as mentioned in Section 1.4.2, the BLM-North Dakota Regional EIS will consider the cumulative impacts of all proposed energy-related facilities in the area.

Sincerely yours,

Harold Kantrud
President

215 South Cascade Street

Otter Tail
POWER COMPANY

Fergus Falls, Minnesota 56537

Phone 218-736-5411

May 16, 1977

MAY 1977

400
415

Regional Director
Upper Missouri Region
Bureau of Reclamation
P. O. Box 2553
Billings, MT 59103

Attention: 415

Subject: ANG Coal Gasification Company
Draft EIS

J-103

Gentlemen:

The subject draft EIS was made available to the public on March 17, 1977, with a 45 day comment period. Although it appears that the comment period has now expired, we wish to attempt to correct some figures which were just brought to our attention.

We refer now to Table 3-38 on Page 3-80 of the draft EIS, and specifically to the figure of 12,000 pounds per hour of NO_2 emitted from two 440 MW units of the Coyote Station. According to Footnote 1 this emission represents 1.32 pounds of NO_2 per MMBTU of coal consumed.

Evidently the emission rate was based on some information the Coyote Project had developed quite some time ago. The earlier calculation for NO_x emission was based on an NO_x concentration of 750 ppm in the combustion gases. Later investigation conducted at a similar 440 MW cyclone-fired unit at the Big Stone Power Plant determined that NO_x was actually about 450 ppm. Therefore, subsequent calculations for our own impact assessment were based on 500 ppm to allow for a reasonable safety factor. This, then, results in a revised emission rate of 3,910 pounds per hour of NO_x for Unit #1 of the Coyote Station.

It seems quite probable that regulations limiting emission of NO_x from lignite boilers will become effective prior to the construction of Coyote Unit #2. Thus, it seems logical to assume that NO_x emitted per hour from the second unit will certainly be somewhat less than from the first. However, even if it is the same, the total emission for both units should be not more than 7,820 pounds per hour of NO_x, not the 12,000 pounds per hour quoted in Table 3-28.

Yours truly,

O. B. Johnson, Project Manager

OBJ:VM:ckk
CC: Mr. Gene Christianson
ND Dept. of Health

No response necessary.

The updated data have been included; however, the coal used at the Big Stone powerplant is not from the South Beulah mine which would supply the Coyote project. Since the nitrogen content of coal varies from mine to mine and since the nitrogen content in large part determines the NO_x concentrations in the combustion gases, the updated data must only be considered tentative.

See above comment.

AMERICAN NATURAL GAS SERVICE COMPANY

MEMBER OF THE AMERICAN GAS ASSOCIATION

ONE WOODWARD AVENUE, DETROIT, MICHIGAN 48226

May 18, 1977

400

413 LA 5/19

Department of the Interior
Bureau of Reclamation
Upper Missouri Region
P. O. Box 2553
Billings, Montana 59103

Attn: Mr. Dean Loomis

Re. Comments on the Draft Environmental Statement

Dear Mr. Loomis:

Attached are our comments on the Draft Environmental Impact Statement, ANG Coal Gasification Company - North Dakota Project (DES 77-11). We would appreciate the opportunity to provide additional comments, if necessary, during the process of finalizing the draft.

If you have any questions concerning either our comments or the questions raised during the hearings, please inform.

Yours very truly,

Gary N. Weinreich

Gary N. Weinreich
Environmental Coordinator
Synthetic Fuels

GNW:jcs
attachment

J-104

DRAFT ENVIRONMENTAL IMPACT STATEMENT
NORTH DAKOTA PROJECT
COMMENTS ON DRAFT BY ANG COAL GASIFICATION COMPANY

Page		
1-12	Add to Paragraph 4 - NGPC has subsequently joined ANGCG as a co-owner of the Mercer County gasification project.	A paragraph describing the role of NGPC in the project has been added to Section 1.1.
1-18	Paragraph 4 - The coal gasification plant requires approximately 27,000 tons of lignite per annual average day.	That plant consumes 27,000 tons of lignite/day; it requires that 31,500 tons be mined per day to provide the 27,000 tons.
1-20	Paragraph 1, Line 7 - Add after ANGCGC: The location of federally owned coal which has been nominated for use on this project under the BLM's EMARS system is shown on page 8-10.	Discussion of the Federal coal alternative is presented in Section 8.1.3.6.
1-29	Paragraph 1 - The construction camp will house approximately 20 percent of the annual work force plus seasonal peaks.	The sentence has been changed to reflect this comment.
1-44	Replace Figure 1-16 (Water Balance) with revised and updated figure to be supplied under a separate cover.	The updated figure has been included.
1-47	Paragraph 2 - Although the final design of the retention ponds are still to be determined through meetings with the State Health Department and State Water Commission, the current sizing of the contaminated water pond is 570,000 cubic feet, not 5 million cubic feet as stated.	This new information has been incorporated.
1-47	Paragraph 3, last sentence - The clarifier overflow would be sent to the process water cooling tower, not to the deep well as stated.	This new information has been incorporated.
1-47	Paragraph 4 - Stormwater runoff from clean areas .... would be collected in open ditches and culverts, routed through a 3,750,000 cubic foot retention pond, before being returned to the natural drainage system	This new information has been incorporated.

PAGE		
1-48	Paragraph 2, Sentence 1 - Overflow from the contaminated rainwater clarifier will not be injected into the deep well as stated. Strike "and overflow from the contaminated rainwater clarifier." The overflow will be reused in the process water cooling tower.	This new information has been incorporated.
1-51	Paragraph 4, line 5-9 - All rates of emissions given are based on utilizing coal with the maximum sulfur (1.7% DAF) and, as a result, the average emission rates would be less. We suggest the fourth, fifth and sixth sentences in the paragraph read as follows: 'Assuming maximum sulfur coal is being used, the combined tar and tar oil would have a maximum SO_2 emission rate of 0.78 lb. SO_2/MMBTU and the combined tar oil, naphtha, and phenol would have a maximum SO_2 emission rate of 0.80 lb. SO_2/MMBTU. Including the Stretford tail gas and coal lock ejector gas, the maximum superheater emission rate would be 0.96 lb. SO_2/MMBTU.	The sample size on which the sulfur content was based was not large enough or extensive enough to firmly establish that 1.7 percent sulfur is the highest sulfur content of the coal that would be used during the 25 years of plant operation. Thus we do not believe that overemphasis on these being maximum emissions is justified.
1-52	Paragraph 4 - The design efficiency of the electrostatic precipitators is 80%.	This new information has been incorporated.
1-53	Paragraph 3 - The third sentence should be changed to read: "The two main flare stacks would be 200 feet above grade and have a tip diameter of 36 inches. The low pressure flare stack is 120 feet above grade and has a 10-inch diameter."	This new information has been incorporated.
1-57	Paragraph 4, Sentence 2 - Should read "Residue from the multiple effect evaporators ..." The residue may have solid or liquid properties depending on water content at the particular time.	The sentence has been corrected.
1-64	Third full paragraph - Strike the third sentence. Moving the water as indicated is not feasible. The used test water will be clean and will be discharged from each section after testing.	This new information has been incorporated.

PAGE

2-86

Paragraph 1 - This paragraph should be revised as follows: The North Dakota coal severance tax became effective on July 1, 1975 and was $0.50/ton escalated on the basis of $0.01/ton for each increase of three points in the wholesale price index. The revenues received from the severance tax are allocated to the State Coal Development Fund. This fund was originally divided as follows:

a. 35 percent to a special fund for distribution to taxing districts impacted by coal developments;

b. 30 percent held in perpetual trust. the income from which goes to the State's General fund;

c. 5 percent allocated to the coal producing counties in proportion to the coal removed from the county; and

d. 30 percent to the State's General Fund.

The 1976-1977 Legislature revised the severance tax to $0.65/ton effective July 1, 1977 and escalated on the basis of $0.01/ton for each one-point increase in the wholesale price index. Furthermore, the Legislature revised the distribution formula for the State Coal Development Fund, grating a larger share to the impacted areas as follows:

a. 35 percent to a special fund for distribution to taxing districts impacted by coal development,

b. 15 percent held in perpetual trust, the income from which goes to the State's General Fund;

c. 20 percent allocated to the coal producing counties in proportion to the coal removed from the county; and

d. 30 percent to the State's General Fund.

This new information plus additional facts regarding recent changes in North Dakota's coal taxes has been added to this Section.

PAGE		
2-88	Paragraph 2, line 4 - "county" should be changed to "district".	The sentence has been corrected.
2-92	Paragraph 1, line 3 - The hospital in Hazen is currently staffed by three doctors.	This new information has been incorporated.
2-93	Table 2-37 - Mercer County currently has a total of 3 physicians as a result of successful recent recruiting.	This new information has been incorporated.
3-6	Paragraph 1 - Start-up gas is burned in a separate incinerator - not in the main flares.	This new information has been incorporated.
3-7	Two of the three power plants examined in the EPA studies of trace element emissions were equipped with mechanical collectors only. The remaining power plant had an electrostatic precipitator but was not equipped with a wet scrubber. None of the plants in the EPA studies had as effective particulate removal system as the one proposed by Basin. The trace element emission from the Basin facility therefore, will be lower than those indicated.	Perhaps. None of the particulate removal systems are capable of removing gaseous mercury; the effectiveness of Basin's system will vary for each specific element and the effectiveness of the system has yet to be determined. The emissions indicated are only meant to be approximations and not exact predictions. It should also be pointed out that the indicated emissions were based on the trace element analysis from the Sasol coal analysis and that other analyses show significantly higher amounts of some of these elements present in the coal.
3-9	Paragraph 1 - Total hourly emissions are based on the assumption that the maximum sulfur coal (1.7% DAF) is being used. The average sulfur in the coal is 1.3% DAF (dry ash free) and average sulfur emissions would be approximately 25% lower.	The fact that emissions were based on 1.7 percent sulfur was indicated on page 3-6 of the DES. See also above response to comment regarding page 1-51.
3-9	Table 3-6 - Gasification plant emissions should be footnoted to reflect that they are based on maximum 1.7% sulfur in coal.	See response to above comment.
3-14	Paragraph 4 - The reduction in visibility were calculated for maximum emission rates under worse case conditions. The percent frequency of occurence is based on the meteorological conditions (wind speed and stability) alone do not reflect the relative frequency that the maximum emission rates might occur. The combined frequency of both occurences would be much lower. Also,	It was indicated on page 3-14 that the figures given were maximum reductions. What is not calcuable, however, are visibility reductions under other than worst case conditions; these could vary anywhere from near zero to the 68 percent figure indicated. depending upon existing weather conditions. Any time the worst case conditions occur visibility reductions would only be slightly less than those indicated even if coal with less than 1.7 percent sulfur was being used at the time because several other elements are involved in visibility reductions.

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	the reduction in the visibility would be apparent to an observer only if he was located on the plume center line at the designated distances. It would not be an area wide problem as implied.	The percent reductions indicated would only be registered by such an observer; other percent reductions would be visible to other observers in other locations.
3-15	Paragraph 1 - The human health effects enumerated in this paragraph are in no way associated with the concentration of emissions resulting from the project. The ambient air concentrations of pollutants are controlled below the safe tolerance levels established by government agencies. Furthermore, health statistics in the vicinity of a coal gasification plant in South Africa have been examined and give no evidence of such adverse effects.	We consider the discussion to be a fair and accurate description of the possible effects of the proposed plants on human health. The "health statistics" were obtained and the data dealt with lack of cancer in plant workers having contact with process byproducts. No data related to any of the health effects discussed on page 3-15 or to health hazards from plant emissions was included in the cited South African report.
3-16	Paragraph 4 - This paragraph which addresses health effects on animals appears to have certain discrepancies. SO_2 is a gas and will not fallout on vegetation as stated. The paper sited appears to state that SO_2 was "infused into plants," which suggests some form of artificial injection of the gas. Finally, no concentration levels are given at which the adverse effects were observed. The gasification plant with its pollution control devices will emit less SO_2 than existing power plants and we know of no such demonstrated immunubiological effects resulting from existing installations.	"Fallout" refers to the descent to earth of pollutants. Since SO_2 is heavier than air it tends to settle near the ground as it cools. It is also taken up by moisture, converted to sulfuric acid, and comes to earth in condensation or precipitation. "Infusion into" has been changed to "uptake by." No studies have been undertaken to determine if immunubiological responses are taking place due to pollution from existing plants; the lack of study does not mean that such effects are not occurring.
3-16	Paragraph 5 - The variations between the trace element analyses shown in Table 1-3 are not errors or discrepancies but normal ranges expected when different samples of a heterogenous substance such as lignite are analyzed for trace elements in very	We agree; however, this paragraph merely points out that the emission rates of these elements would vary from those shown on page 3-7, which were based on only one sample (Sasol), depending upon the amount of these elements present in the coal being used.

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	low concentrations.	
3-22	Paragraph 3 - Mention should be made of the fact that no plant wastewaters are discharged to surface streams.	Mention of this was made in Section 1.5.5.2 of the DES and need not be repeated here.
3-33	Paragraph 3 - The effects of air emissions on vegetation is expected to be minimal. Existing facilities in the vicinity emit greater amounts of SO_2 and NO_x than the proposed gasification plant with no adverse effects on vegetation demonstrated.	No studies have been conducted in the vicinity to determine what effects the emissions may be having. The lack of study is not a valid reason for saying there are no effects.
3-48	Paragraph 2 - Since appreciable amounts of deposited airborne material have not been detected in studies conducted by the University of North Dakota at two large lignite-fired power plants at Stanton, North Dakota, similar effects are not anticipated as a result of this project.	The study mentioned did not run analyses on surface waters but did find some deposited material in the soil near the powerplants. Soils downwind of the plants where the main effect of the plume would be felt were not examined.
3-64	Paragraph 1 - The construction camp will house approximately 20% of the work force plus seasonal manpower peaks.	The sentence has been corrected.
3-70	Paragraph 5 - The impacts on water supply and public health indicated in this paragraph are certainly not probable impacts, especially in light of the water improvements sited on page 3-74 and 75.	The improvements cited on pages 3-74 and 3-75 are only a part of the improvements that would be required to accommodate the potential population influx from all proposed developments in the area. Whether or not the water supply and public health impacts actually occur depends on local community action to further expand the appropriate facilities.
3-80 & 81	The adverse air quality and water quality impacts enumerated on these pages are not likely to occur as a result of the proposed projects. Dispersion characteristics in the project vicinity are excellent and will result in adequate dispersion of all emissions. Other facilities in North Dakota do not experience the types of adverse effects indicated on these pages.	The actual likelihood of the occurrence of these impacts will increase as the number of coal-fired plants in North Dakota increases. Emitted pollutants must go somewhere and recent studies throughout the U.S. have found that the pollutants end up in soils, waters, plants, and animals. There is nothing about North Dakota that would exempt the State from the same chemical and physical laws that operate elsewhere.
3-81	Paragraph 5 - No mining will occur near urbanized areas.	The paragraph does not say mining will occur near urban areas.
3-82	Paragraph 2 - As shown in Table 3-8 on page 3-15, the percent frequency of occurence for significant visibility reduction periods is less than 1.5% or less than 6 days per year. Even	The paragraph refers to the cumulative impacts of all currently proposed coal development in the area; your figures only apply to the ANGCGC and Basin Electric plants.

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	during these infrequent periods of unusual meteorological conditions, visibility reduction would average less than 20%. This should not affect photo-synthesis or crop productivity. Direct damage to crops from SO_2 or NO_x has not been demonstrated from existing sources in the area and no adverse effects on animal species has been attributed to emissions from existing sources.	No studies have been undertaken to determine if such effects are occurring or not.
3-82	Paragraph 3 - No chemicals will be used indiscriminately at the facility.	There is always a possibility of human carelessness.
3-84	Paragraphs 1 and 2 - The overcrowding and stressing of public services is not necessary if proper advance planning and mitigative measures are adopted. The population remaining after the construction peak need not be burdened with debt obligation since coal severance and conversion tax revenues are redistributed to the affected counties to cover these impact costs.	We agree; however, such advance planning and construction of new facilities is not taking place thus it seems more and more likely that these impacts will occur. Recent changes in North Dakota coal tax distribution laws make the long-term financial outlook less severe and the section has been modified accordingly.
4-84	Paragraphs 1 and 2 - Since the release of the Draft EIS, the North Dakota Legislature has passed legislation which will enable the short and long-term financial needs of the local governments to be accommodated.	The new legislation should help meet the long-term financial needs of local governments (see Section 2.3.2); however, short-term and front-end financial needs are still a problem as long-term debts would be acquired by local communities. Local leaders may be hesitant about assuming long-term debts.
4-1	Paragraph 3 - There are no SO_2 New Source Performance Standards (NSPS) for gas-fired steam boilers as shown in the table.	The standards have been corrected.
4-2	Paragraph 2 - NSPS for fossil fuel-fired steam boilers are applicable for such steam boilers, within a gasification plant if they are fired by fossil-fuels.	The paragraph has been revised in line with the most recent information regarding the applicability of the standards to the proposed plant.
4-6	Item #2 - The expansion gas contains CO_2 and H_2S, not CO and H_2S.	The sentence has been corrected.

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4-8	Paragraph 2 - Title 38 of the North Dakota Century Code should be substituted for SB 2095.	The sentence has been corrected.
4-16 to 4-18	The conditions to the Mercer County Conditional Use Permit have been changed by the Mercer County Planning Commission and will be forwarded under separate cover.	The new conditions have been included.
5-1	Paragraph 3 - The visibility reduction referred to here occurs rarely and only under certain meteorological conditions.	See above response to comment regarding page 3-14.
5-1	Paragraph 4 - Although an accidential coal fire occurred at an abandoned mine in the area, no such occurence is expected at a manned facility, where operators will be constatly observing the coal piles for early signs of oxidation.	Such fires are always a possibility
5-1	Paragraph 9 - Increased consumption of gas as a result of this project is very unlikely. During the period that this plant is in operation, the effect of 250 million cubic feet of SNG per day will be to slow the rate of reserve depletion and to help maintain, not increase, existing supply levels.	Increased consumption over and above what would have been consumed without the availability of SNG is a distinct possibility.
5-2	Paragraph 3 - Contamination of surface waters due to air emissions is extremely unlikely. Studies conducted by a state university in the vicinity of two existing power plants in North Dakota did not detect any such phenomenon (Research Report #12, UND Institute for Ecological Studies).	The referenced study did not conduct analyses of surface waters to determine if such a phenomenon was taking place. Since such contamination has been demonstrated in other areas of the country, it is likely that some contamination would occur. Whether or not it would occur at levels which would be harmful has yet to be determined.
5-3	Paragraph 3 - Qualification is required with regards to the effects of SO_2, NO_x and heavy metals. The study sited above in 5-2 stated that the opposite was true in the vicinity of the Stanton, North Dakota power plants. We know of no evidence that conclusively links emissions at the low concentrations resulting from these proposed projects with damage to exposed flora.	We believe you mean paragraph 5. The cited study did not examine plants for effects from pollutants thus it seems inconsistent for it to conclude that no such effects existed.

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5-4	Paragraph 2 - The possibility of any affect on faunal species due to the emission of trace elements into the atmosphere is extremely remote. The excellent dispersion characteristics of the area and the low emission rates of trace elements make the potential for affecting faunal species negligible. Again, no such effects have been discovered in the vicinity of existing plants in North Dakota.	One effect to animals recently noted in North Dakota is an increased incidence of stillborn calves downwind of the Stanton powerplants. Again, the lack of study does not mean that there are no effects.
5-4	Paragraph 5 - An immeasurable increase in salinity is not a major impact as suggested in this paragraph.	The word "major" was changed to "main."
5-5	Paragraph 2 - The cost to local governments and the increase in long-term debt will occur only if other measures are not adequately implemented. This impact is not an unavoidable impact as proper legislation has the potential to completely mitigate this potentially adverse impact.	Since the proper legislation has not been passed, the spectre of long-term debt is more and more unavoidable.
5-5	Paragraph 3 - Recent legislation has made tax revenues available for the construction of facilities and for the provisions of services in a timely manner, eliminating the time lag indicated in this paragraph.	A discussion of recent coal tax legislation has been added to Section 2.3.2. The new legislation does not solve the problem of communities having to incur long-term debts.
6-1	Paragraph 1 - Weekly coal consumption is approximately 190,000 tons and total useage is approximately 245 million tons over 25 years.	See response to comment below regarding page 7-1.
6-1	Paragraph 2 - It should be pointed out that waiting for second generation gasification processes will do nothing to satisfy needs in the immediate future. Second generation processes are not likely to be commercialized prior to 1995 and will probably not show any significant advantages from efficiency or cost points of view. Furthermore, and while speculative, preserving the coal as a resource for a longer period may render it valueless if solar	The paragraph refers to all future technologies, not just future gasification technologies. If solar or other forms of energy are successfully harnessed then the impacts associated with the proposed project would have been a waste of human and environmental resources because the coal would still be valueless.

and other forms of energy are successfully harnessed, eliminating the need for coal. In effect, coal is needed most at the present time and should be utilized as an important part of the national energy program.

7-1 Paragraph 1 - The first two sentences should read: "About 245 million tons of lignite would be mined and totally and irretrievably consumed by the gasification plant. This amounts to 16 percent of the 1.5 billion ton reserve near the plant-mine site." Sales to Basin Electric's Antelope Valley Station should not be included as part of the gasification plant consumption.

The 351 million tons of lignite would have to be mined for the gasification plant whether sold or not; therefore, the 351 million tons is a resource commitment to the proposed project. The 351 million tons represents 37 percent of the 947 million tons of currently recoverable lignite near the plant site.

B-7 Footnote 2 - Should read "maximum case during upset conditions." Also electristatic precipitator efficiency should be 80%.

This new information has been incorporated.

I-4 Emissions from the phenosolvan gas liquor separator flare (low pressure flare) should be footnoted to indicate that the value given is the maximum case during upset conditions.

This new information has been incorporated.

Iowa Confederation of Environmental Organizations

MAY 23 1 03 PM '77 P.O. Box 1147 • Ames, Iowa 50010

May 20, 1977

Mr. Robert L. McPhail
Bureau of Reclamation
U.S. Department of the Interior
Federal Building
Billings, MT 59101

Dear Sir:

With regard to the Draft EIS (DES 77-11) on the ANG Coal Gasification site in Mercer County North, Dakota, there are two considerations unique to this project which we feel should be discussed.

1. The practice of "rolled in" costs of SNG as described in the EIS would require a clarification by the FPC and subsequent Benefit/Cost considerations to each class of consumer.

2. The emissions unique to such a Lurgi process which include a large family of carcinogenic compounds have not been examined in the degree of detail commensurate with their threat to health.

The EIS casually dismisses these as occasional or insignificant or lumps them in the hydrocarbon class, implying that meeting the state and federal regulations of the Clean Air Act is sufficient. This is not the case. NEPA requires a "full disclosure" and assessment of these unique threats.

The relationship of cancer incidence to humans exposed to carcinogenic organics in the synthetic fuel industry has been summarized by D. Y. Sauter in a report, "Synthetic Fuels and Cancer", November 1975, released by the Scientists Institute for Public Information. The documented incidences observed for cancer occurring in workers in the synthetic fuels industry should be considered carefully and discussed in the EIS.

The emissions anticipated under both normal and worst conditions should be discussed and considered in comparison with emission of similar installations in Scotland, Europe and South Africa.

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This matter will be considered by the FPC during its hearings for a Certificate of Public Convenience and Necessity.

The gasification process is an enclosed process and exposure could only occur from tar, tar oils, and vent gases. The tars and tar oils would be incinerated in the boilers and superheaters. Vent gases would incinerated in the flares except for a small amount of residual raw gas which would be released into the atmosphere. These emissions would meet all health, safety, and environmental standards.

No increased incidence of cancer has been found in workers at the Sasol plant after average exposures of 8 to 12 years. See also response to comment from the Department of Health, Education, and Welfare regarding occupational health.

Emissions in the EIS are for worst case conditions; normal conditions would entail lower emissions. Similar installations in other countries do not have the control devices the proposed plant would contain thus any comparison would be meaningless.

The proposed boiler fuel for steam generation, namely the by-products, tar, oils, naptha and phenols, are to be combusted in such large amounts that specific information on the experience with such combustion techniques and their efficiencies should be available. The incomplete combustion of these heavy cyclic hydrocarbons present possibilities of additional airborne carcinogenic compounds such as benzo(a)pyrene, etc.

The polycyclic aromatic hydrocarbons released from this Lurgi gasification process are new in the regional threats they pose and become particularly awesome if one considers this ANG plant the first of many proposed for the Western North Dakota region.

Sincerely yours,

M. M. O'Toole

M. M. O'Toole
Acting Secretary
Iowa Confederation of Environmental Organizations

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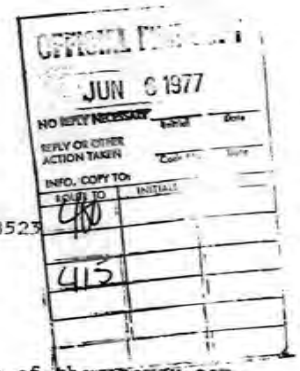
The by-product fuels would be burned in the boiler at 3500° F. and in the superheater at 1600° F. Complete combustion should result at these temperatures. During start-up of the boilers, auxillary fuel would be used until operating temperatures are reached.

See above responses.



Beulah, ND 58523
May 22, 1977

Gentlemen:

We understand and respect the position of the energy company. But we the Landowners have needs also. Agriculture cannot be sacrificed in North Dakota.

We will list some of our major concerns. We realize it will take the combined efforts of the Landowners and the energy companies, to overcome many of these concerns.

1. Sixty percent of our wells are located in the coal veins. Massive mining will destroy theses wells.

2. Mine roads, power lines, and water lines will definitely hamper our farming operations. We maintain that when ever possible they should follow section and quarter section lines.

3. Our way of life will be distroyed. Our grandfathers spent endless hours and money to homestead and improve these lands which we now call home.

4. Our health facilities are not adequate for this impact.

5. Our recreation facilities will not be adequate.

6. Our elderly citizens will be hurt by higher prices, lack of medical facilities, and general lack of facilities.

7. Coal Taxes are not reasonable to protect Mercer County. Energy companies were definitely not helpful when we tried to pass an adequate severance tax.

8. We feel North Dakota is being exploited by the energy companies. Our land and water will be consumed but reclamation has not been proven to us. We are especially concerned about the cost of reclamation. At some future time the cost may be to high and we will be left with spoils for land.

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JUN 14 1977

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Mr. Eugene E. Keller, President
Mercer County Landowners
Beulah, North Dakota 58523

Dear Mr. Keller:

We have received your letter of May 22, 1977, listing major concerns regarding ANG Coal Gasification Company's proposed gasification plant for Mercer County. We are aware that these are major problems and we have tried to address them in our draft environmental statement which was released March 17, 1977. Unfortunately, we have no ready solution for these issues. We agree that their resolution will take the combined efforts of the landowners and the energy companies.

By copy of this letter we are forwarding your correspondence to ANG Coal Gasification Company for further response. If there are any questions please contact Dean Loomis or Fred Crase at (406) 657-6605.

Thank you for informing us of your concerns.

Sincerely yours,

Robert L. McPhail

Regional Director

cc: Mr. Earl C. Kirchner, Assistant Director, Coal Reserves, Mining, and Community Services, American Natural Resources Company, One Woodward Avenue, Detroit, Michigan 48226 (w/copy of incoming correspondence)

bc: (415)

9. Last, but not least important, we do not feel that Antelope Valley is a proper site for a gasification complex. Antelope Valley is under lain by an auqifer. During heavy rainfall the Valley is flooded. Wastes could easily end up in Hazen.

Sincerely yours,

Mercer County Landowners
Eugene L. Keller President
Gilbert Ost Vice President
Wally Keller Director
Floyd Wiegum Director
Leon Walz - Director
Joe Weidrick - Sec. & Treas.